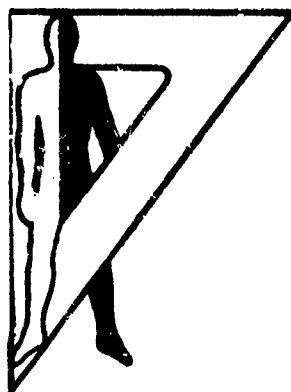


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AN ANNOTATED BIBLIOGRAPHY OF THE LITERATURE DEALING WITH
THE PHYSIOLOGICAL CORRELATES OF COGNITIVE PERFORMANCE.

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Nicholas J. Carriero,
Michael W. Cameron,
J. D. Craig,
Jules L. De Mance,
John Fite, Jr.

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) <table border="0"> <tr> <td>Physiological Correlates</td> <td>Physiological Measures</td> <td>Work Load</td> </tr> <tr> <td>Human Performance</td> <td>Alertness</td> <td>Accuracy</td> </tr> <tr> <td>Cognition</td> <td>Attention</td> <td>Information Load</td> </tr> <tr> <td>Overstimulation</td> <td>Monitoring Performance</td> <td>Mental Load</td> </tr> <tr> <td>Understimulation</td> <td>Vigilance</td> <td>Selective Attention</td> </tr> </table>			Physiological Correlates	Physiological Measures	Work Load	Human Performance	Alertness	Accuracy	Cognition	Attention	Information Load	Overstimulation	Monitoring Performance	Mental Load	Understimulation	Vigilance	Selective Attention
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AN ANNOTATED BIBLIOGRAPHY OF THE LITERATURE DEALING WITH
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INTRODUCTION

A problem of perennial concern in man-machine systems is the efficiency of the human operator. Both extremes of operator loading (overload or underload) can have dire consequences in military settings. For example, an overburdened air-traffic controller may lose track of a particular aircraft and either direct another plane into its path or not warn it in time to avoid a collision with a mountain or other environmental hazard. An underloaded radar monitor, on the other hand, may suffer a lapse of attention due to "boredom" or "mental fatigue" and fail to detect incoming enemy aircraft in sufficient time to insure optimal interception. One approach to remedy this problem is to determine to what extent the physiological status of the operator may be used as an indicant of his performance efficiency.

The present bibliography is an outgrowth of this approach. It gathers the research literature that deals with the physiological correlates of cognitive performance (broadly defined) in situations that have significance and import for military operations. In particular, the focus is on studies that delineate the relationship between physiological variables and optimal or degraded performance.

There are three major military applications of such information: (1) assessment of operator status in work environments—e. g., the physiological state of the operator could be evaluated while he performed his duties and when they deviated from optimal levels the operator could be relieved; (2) selection of operators—e. g., if certain physiological profiles are found to accompany superior performance in particular tasks, these profiles could be used as selection criteria and (3) training programs—e. g., biofeedback techniques might make it possible to develop optimal physiological profiles in that segment of the population which initially lacked them.

Since our goal in compiling this bibliography was relevance to military applications, article selection was limited in the following manner. Studies were excluded if they:

1. employed experimental techniques that couldn't be used in operational environments (e.g., studies of intracranial brain activity);
2. focused exclusively on populations that wouldn't be found in operational military environments (e.g., psychiatric patients);
3. focused solely on learning;
4. used stresses that are either not found in, or are more intense than those found in military environments (e.g., severe electric shock);
5. involved physical exertion beyond that required in military monitoring tasks;
6. failed to determine the relationship between the physiological activity measured and adequacy of performance.

Exceptions were made to these restrictions in instances where an article made a significant methodological or theoretical contribution to this research area.

Material for this bibliography was gathered from the Psychological Abstracts, Dissertation Abstracts, Ergonomics Abstracts, bibliographies from related areas, requests to authors working in this field for reprints of their work and the names of other researchers in the area, and

reference lists from selected articles. While the literature searched covered the period from 1965 to June 1977, earlier material was included when it was received from the contacted authors or encountered in other sources.

Whenever possible, the abstracts which appear in this bibliography are taken directly from the cited article. If the article did not contain an abstract or summary, abstracts appearing in one of the sources mentioned above were used if available. In a few instances, when the above alternatives were lacking, we have either supplied the abstracts ourselves or used appropriate sections of the articles as an abstract. Some of the abstracts have been abridged from their original size to make them more suitable for the present purpose.

A

- 1 Abraham, P., & McCallum, W. C. The CNV and the spiral after-effect. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 205-208.

The CNV and spiral after-effect (SAE) were investigated in psychotic patients and normal controls. Although both SAE and CNV measures differentiated psychotic from normal groups in proportion to the presence of certain severe symptoms, the SAE measure appeared most closely linked to fluctuations of the symptoms, whereas the CNV measures seemed more characteristic of the underlying disorder. The relevance of the findings to hypotheses seeking to relate cerebral slow potential changes and arousal is discussed.

- 2 Adam, J., Brown, T., Colquhoun, P., Hamilton, P., Orsborn, J., Thomas, I., & Worsley, D. Nychthermeral rhythms and air trooping: Some preliminary results from 'exercise medex.' In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

Although the general picture that emerges from these preliminary results suggests that phase adjustment of both physiological and performance rhythms occurred very rapidly following the time-zone transition from U.K. to Malaysia, certain anomalies in the data require further investigation before a definite conclusion on these lines can be made. The analysis of urine samples for cortisol and electrolytes which is now proceeding may help to shed some light on these anomalies, which were particularly evident in the calculation test scores. Until this analysis, and also that of the memory test scores are complete, we should be cautious in our interpretation of a finding which, at its face value, is strikingly different from that typically reported by other workers in this field.

- 3 Adamowicz, J. K., & Gibson, D. Cue screening, cognitive elaboration, and heart-rate change. Canadian Journal of Psychology, 1970, 24, 240-248.

Two experiments with 36 undergraduates examined changes in heart and respiration rates as a function of 2 task-attention demand and 2 verbalization conditions. Findings show that cardiac response is a function of (a) verbalization requirements, and (b) the interaction of task-attention demand and verbalization requirements. Heart rate increased above the base line if the S was required to summarize and report the contents of a taped passage after its completion and decreased if the S was required to attend only. Respiration rate increased under both the verbalization and no verbalization conditions, indicating directional fractionation of response. Findings are interpreted in terms of arousal theory and in relation to the Lacey paradigm.

- 4 Adamowicz, J. K., & Gibson, D. Verbalization, cognitive effort, and heart rate alteration. Canadian Journal of Psychology, 1972, 26, 1-10.

Thirty Ss were assigned to six experimental conditions involving three levels of post-task verbalization requirement and two sensory presentation modalities. Task consisted of a complex essay. Heart and respiratory rates were recorded during five phases of the experiment: baseline, instructions, task, cognitive organization, and recall of facts. Heart rate varied as a function of cognitive demand of task and the interaction of verbalization requirements and cognitive task demand. Respiration rate varied as a function of experimental phase and the interaction of modality of presentation and experimental phases. Results were discussed with reference to the Lacey paradigm and general activation theory.

- 6 Adamowicz, J. K., Gibson, D., & Kaufman, D. Respiratory change and mental task gradient. Psychonomic Science, 1967, 9, 183-184.

Examined the proposed connection between mental task difficulty levels and heart rate change using a respiration measure and pretested intensities of mental task demand and white noise for 27 Ss. Similarity of direction and magnitude of results between studies based on cardiovascular measures and the present respiration findings indicate that conclusions can be generalized physiologically.

- 6 Adey, W. R. Spectral analysis of EEG data from animals and man during alerting, orienting and discriminative responses. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

We have directed much effort to the elucidation of patterns in scalp EEG records in man that might be similarly correlated with states of focused attention and discriminative performance. Necessarily, quantitative criteria have been established by extensive computational estimates of EEG spectral parameters, since their evaluation even by simple automated techniques, such as analogue methods of frequency analysis, are quite inadequate for this purpose. In turn, these parameters from digital spectral analysis have been used in further automated pattern recognition studies, in which the computer has been assigned the task of selecting parameters that best classify epochs of EEG records in individual subjects in particular test situations, including correct and incorrect decision-making.

- 7 Adey, W. R., Kado, R. T., & Walter, D. O. Computer analysis of EEG data from Gemini flight GT-7. Aerospace Medicine, 1967, 38, 345-359.

A computed analysis, using digital techniques, was performed on closely spaced samples of 55 hours of EEG data from Astronaut F. Borman, with calculation of auto-spectral and cross-spectral density distributions and coherence functions. Flight data were compared with extensive baseline collections from the same subject in laboratory task performances, in a Gemini flight simulator, and in sleep. Two channels were recorded for the first 29 hours of flight and one thereafter. A detailed analysis of the prelaunch period and first orbit indicated an anticipatory arousal before launch, with changes in power distribution and coherence during the first orbit consistent with strong orienting reactions. Careful assessment of awake flight records throughout the remainder of the 55 hours indicated increased power in the theta band (4 to 7 cycles/sec) by comparison with laboratory and flight simulator data. The genesis of this increased theta rhythm in orienting reactions associated with initial exposure to weightlessness is discussed, and the need emphasized for data gathered at later times in longer flights to elucidate persistent shifts from groundbased norms. Sleep analyses from the first two "nights" in space are presented, with clear evidence of minimal sleep on the first night, and four consecutive normal 90 minute cycles on the second night. The sensitivity of EEG records to changing states of alertness and focused attention is reviewed, and the value of the method, in conjunction with adequate computation, for pilot-astronaut monitoring is emphasized.

- Adkins, S. Performance, heart rate, and respiration rate on the day-night continuum. Perceptual & Motor Skills, 1964, 18, 409-412.

Each of 15 female college students was tested at 4 PM, 10 PM, 4 AM, and 10 AM. Pulse rate and respiration rate were gauged directly before task performance. An RT task was followed by time estimation. Pulse and respiration rates were slowest at 4 AM and increased significantly by the 10 AM testing, followed by a gradual decline. Both RT and time estimation were poorest at 4 AM, reached a peak at 10 AM and gradually declined. These findings agree with previous data which show that, as activation level increases up to a certain point, performance improves. No Ss showed over-activation previously observed to lead to disintegration of performance. A major criticism of the procedure was discussed.

- Aitken, R. C., & Gedye, J. L. A study of two factors which affect arousal level and the apparent duration of a ten-minute interval. British Journal of Psychology, 1968, 59, 253-263.

Interview studies of aircrew suggested that the apparent duration of an interval during flight might be affected both by the demand made on the individual by his allotted task and by the amount of background distraction. Eight pilots were isolated for 4 intervals of 10 min. During 2 intervals Ss were required to perform a simple tracking task, in the other 2 they were not required to do anything; on 1 occasion for each task condition they were exposed to distracting stimulation. The palmar skin resistance was measured every ½ min during each 10-min interval; the S then estimated its duration and indicated how alert he had been during it. The apparent duration was increased by the presence of distraction and decreased by the performance of the task; however, the effects of distraction and performance on alertness and skin conductance were both in the direction of an increase in arousal. Arousal changes could not account for more than an insignificant proportion of the observed alterations in apparent duration. It is concluded that an explanation in terms of the way in which attention is organized under the particular conditions of isolation obtaining is consistent with the findings.

- 10 Alluisi, E. A. Influence of work-rest scheduling and sleep loss on sustained performance. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

Several inferences can be made from the data. First, the diurnal cycling of axillary temperature is clearly evident. Secondly, the period of this cycle is slightly longer than 24 hours. Thirdly, the cycling clearly continued without much abatement for the first 20 or 25 days before becoming somewhat flattened (statistically significant only during the last 5 days).

As was shown previously, performance may show the same sort of rhythm, but with a lag of about 2 hours or so, depending on certain other factors. The periodicity is greater than 24 hours there too; this has been found in other studies of work-rest scheduling with persons working on a 4-2 schedule. The points of peak performance (and activation) appear to slip about 2 hours every 5 days or so.

- 11 Alluisi, E. A., & Chiles, W. D. Sustained performance, work-rest scheduling, and diurnal rhythms in man. Acta Psychologica, 1967, 27, 436-442.

An attempt has been made here to summarize a 10-year program of research that has dealt with sustained performance, work-rest scheduling, and diurnal rhythms in man. The general conclusions reached are: (1) man can probably follow a 4-4 work-rest schedule for very long periods without detriment to his performance; (2) for shorter periods of 2 or possibly 4 weeks, selected men can follow a more demanding 4-2 work-rest schedule with reasonable maintenance of performance efficiency; (3) in following the more demanding schedule, man uses up his performance reserve and so is less able to meet the demands of emergency conditions such as those imposed by sleep loss; (4) the diurnal rhythm which is evidenced in physiological measures may also be evidenced in the performance depending on the information given to, and the motivation of, the subjects, and depending also on the total work load; even where motivation is sufficiently high, the cycling may be demonstrated when the operator is overloaded; and (5) the methodology employed yielded measures that are sensitive to the manipulation of both obvious and subtle experimental variables.

- 12 Alluisi, E. A., Coates, G. D., & Morgan, B. B., Jr. Effects of temporal stressors on vigilance and information processing. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

The data of two control and ten experimental studies of the effects of continuous work and sleep loss on sustained multiple-task performance, representing more than nine man-years of synthetic work by 89 different subjects, were reanalyzed to permit comparisons of the performances of three watchkeeping tasks and two active tasks that are time-shared in a multiple-task performance battery (MTPB). Specific comparisons were made of the two control groups, of the effects of 48 hours of continuous work and sleep loss with and without the employment of pulse-rate and EEG-theta biofeedback and autoregulation, of the effects of the duration of continuous work and sleep loss (36, 44, or 48 hours), of the effects of the duration of rest-and-recovery following 36 hours of continuous work (12, 6, 4, 3, and 2 hours), and of circadian rhythm and 36-hour continuous work interactions. Eight specific conclusions are reached, the most general of which is that the relevance of typical laboratory research with single-task watchkeeping tests, including the capability of its findings being generalized to, and implemented in, practical situations involving monitoring performances within operational man-machine systems is seriously questioned, if not compromised, by the findings.

- 13 Alsip, J. E., & Edwards, D. C. A more objective method of ordering stimuli on the intake-rejection continuum. Psychophysiology, 1971, 8, 244. (Abstract)

The authors have proposed that viewing time (VT), the length of time looking at a visual stimulus, is a measure of the degree of intake-rejection. Specifically, it was hypothesized that longer VTs would be associated with greater degrees of stimulus intake and, therefore, would result in greater heart rate (HR) decelerations. Likewise, shorter VTs would be associated with lesser degrees of intake and smaller HR decelerations. Also, longer VTs would accompany smaller skin resistance (SR) decreases, whereas shorter VTs would accompany greater SR decreases. Twenty Ss were shown 32 photographic slides for as long a period as they desired, and measures of VT, HR change ($HR \Delta$), and SR change ($SR \Delta$) were recorded. These measures were then correlated for each S and for each stimulus.

In a related experiment, 20 different Ss were shown the 32 slides in pairs. It was hypothesized that that slide of a given pair commanding the greater amount of attention, i.e., the longer VT, would be accompanied by a greater HR decrease and a smaller SR decrease than the other slide. Correlations between the VT differences of the two members of a pair of slides and the corresponding $HR \Delta$ and $SR \Delta$ differences were computed.

The results of these two experiments indicate little value in operationally defining the intake-rejection continuum in terms of VT, unless the suggested refinements of this procedure are undertaken.

- 14 Amadeo, M., & Shagass, C. Brief latency click-evoked potentials during waking and sleep in man. Psychophysiology, 1973, 10, 244-250.

Very early auditory evoked potentials, commencing from 1 to 2 msec after stimulation, can be recorded from human scalp by averaging; they appear to be generated in the VIII nerve and brain stem structures. This study was conducted to obtain data concerning possible variations of these early auditory responses with sleep in man. Our results show little or no change in the amplitude and latency characteristics of these potentials from waking to sleep or between sleep stages. Prolonged stimulation, during waking or sleep, produced increases of latency and a tendency for decrease of amplitude. The findings were interpreted to indicate that changes in latency and amplitude of later components of auditory evoked responses during sleep occur at levels above the brain stem. They also support the view that the increased threshold for auditory arousal associated with sleep is mediated centrally rather than peripherally.

- 15 Aminov, N. A. [Functional states during monotonous work and the balance of the basic nervous processes.] Voprosy Psikhologii, 1974, 2, 77-83.

Studied the effect of monotony on work performance. Forty Ss 17-28 yrs old were given the task of measuring the areas of a large number of circles, and their EEG, galvanic skin response (GSR), and number of errors were recorded. Ss could be divided into 2 groups on the basis of their alpha frequencies and alpha-wave energy: those with a predominance of nervous excitation and those with predominant inhibitory processes. Changes in the GSR level as a function of time spent at the task were of 4 types: increasing, decreasing, U-shaped, and fluctuating. Ss in whom skin resistance increased or followed a U-shaped function showed the largest number of errors. Ss showing a moderate level of arousal demonstrated little decrement in performance; Ss with a low level of arousal and a predominance of inhibition showed impaired performance as the task continued, as did Ss with a high level of arousal and the predominance of excitatory processes.

- 16 Andreassi, J. L. Skin-conductance and reaction-time in a continuous auditory monitoring task. American Journal of Psychology, 1966, 79, 470-474.

Continuous measures of palmar skin-conductance (PSC) were taken as S responded to aperiodic auditory signals presented against a white noise background. Thirty-two reaction-time (RT) trials were taken for each of 16 Ss over a 40-min session. The results indicated that Ss had significantly faster RTs on the 10 trials in which PSC was highest as compared to the RTs for the 12 middle and 10 lowest PSC trials. There were decreases in PSC as the experiment progressed. The sharp decrease in PSC between the first and second 10-min segments of the experiment was accompanied by a significant increase in RT.

There was no upturn in RT at the highest levels of PSC and it was suggested that in certain situations S's level of arousal must be actively manipulated to achieve an inverted "U" relation between bodily activity level and performance.

- 17 Andreassi, J., & Huntley, M. S. Effects of signal patterning upon vigilance performance and physiological responses. (Report No. IH-62.) Orlando, FL: US Naval Training Device Center, January 1967.

The purpose of the present investigation was twofold: (1) to determine the effect of signal patterning upon physiological responses and time to detect signals; (2) to study performance of subjects (Ss), with and without patterning, under conditions in which they were either informed or uninformed about the signal patterning.

Vigilance performance and physiological responses with variable interval (VI) and fixed interval (FI) signal patterns were studied in four groups of Ss. Three of the four groups were required to make responses (telegraph key presses) in order to detect signals. Reaction time (RT) was used as the performance measure while heart rate (HR), palmar skin conductance (PSC) and galvanic skin responses (GSRs) were the physiological measures. Each S was tested in two separate one hour sessions on each of two days.

The results indicated that there was a tendency for RTs to be faster under the FI schedule of signals than with the VI. The HR and PSC measures showed higher variability with the VI schedule while GSRs were more variable under the FI schedule. Faster RTs tended to be related to higher levels of HR, PSC and GSRs. It was suggested that: (1) faster RTs under the FI schedule reflected greater learning of the regular signal pattern; (2) faster RTs with higher degrees of physiological activation were due to greater numbers of sensory impulses which travelled cortically and had the effect of improving alertness and readiness to respond. Several implications of these results for training were discussed.

- 13 Andreassi, J. L., Okamura, H., & Stern, M. Hemispheric asymmetries in the visual cortical evoked potential as a function of stimulus location. Psychophysiology, 1975, 12, 541-546.

The averaged visual cortical evoked potential (VEP) was examined in two separate experiments as a function of stimulus location. The VEP was recorded from over left and right occipital hemispheres and stimuli were presented binocularly.

The results of Experiment I, in which three stimulus locations were used, indicated that stimuli presented in the left visual field resulted in shorter VEP latencies at the right occipital area than the left, while for stimuli presented in the right visual field, the opposite occurred. In Experiment II, seven locations were used and similar VEP latency asymmetries were observed. While no hemispheric amplitude asymmetries were found, there was a trend toward a decrease of VEP amplitude with increasing distance of stimulation from the fovea.

The latency asymmetries may be explained in terms of the angle at which the stimuli impinge upon the retinas of the two eyes from different locations. Direct stimulation is produced at the primary projection area, whereas indirect stimulation probably occurs at the secondary area, after crossover of impulses via the corpus callosum.

- 14 Andreassi, J. L., Rapisardi, S. C., & Whalen, P. M. Vigilance performance and physiological responses under fixed and variable signal schedules. (Report No. IH-71.) Orlando, FL: Naval Training Device Center, Life and Behavioral Sciences Department, May 1967. (DDC No. AD-655 619)

The present investigation was designed to: (1) determine the effects of signal patterning upon physiological responses and RT to the signals; and (2) provide some information with respect to the roles of expectancy and arousal in monitoring performance.

Monitoring performance and physiological responses with variable interval (VI) and fixed interval (FI) signal patterns were studied in four Ss over an average of 10 days each. The Ss were required to expend some effort in order to obtain the critical signals. Reaction time (RT) was used as the performance measure while heart rate (HR), palmar skin conductance (PSC) and galvanic skin responses (GSRs) were the physiological measures.

The RTs were significantly faster under the FI schedule than with VI. The PSC and GSR measures were significantly higher under FI than with VI, while HR was significantly greater with VI as compared to FI. Cumulative records showed typical response patterning to FI and VI schedules for three of four Ss. On the basis of these results it was suggested that: (1) faster RTs under the FI schedule reflect greater learning of the signal pattern under the FI schedule and perhaps the existence of an internal timing mechanism; (2) signal patterning does have an effect on physiological response and RT; (3) the difference between conductance phenomena and heart responses to the two signal patterns may be due to differential responsivity of the autonomic nervous system; and (4) monitoring performance contains elements of both expectancy and arousal.

- 20 Andreassi, J. L., Rapisardi, S. C., & Whalen, P. M. Autonomic responsivity and reaction time under fixed and variable signal schedules. Psychophysiology, 1969, 6, 58-69.

Measured heart rate (HR), palmar skin conductance (PSC), GSRs, and RT while 4 undergraduates detected critical signals which occurred at either fixed or variable intervals (VIs). Ss were required to make responses in order to detect the signals. Results showed that: (1) RT was significantly faster with a fixed signal schedule; (2) HR was significantly higher with a VI schedule than with the fixed interval (FI); and (3) PSC and GSRs were significantly higher with FI than with VI. It was suggested that the term "improved expectancies" of J. S. Adams and L. R. Boulter be adopted to explain the reason for superior RT performance with FI patterning. Findings concerning HR were interpreted within the framework of the J. I. Lacey, et al. concept that acceleration of HR occurs in tasks involving cognitive activities, while deceleration is observed in situations involving primarily perceptual functioning. It was suggested that PSC and GSRs represent physiological correlates of expectancy, and that their elevated level may reflect readiness to respond when critical signals occur at regular intervals.

- 21 Andreassi, J. L., Stern, M., & Okamura, H. Visual cortical evoked potentials as a function of intensity variations in sequential blanking. Psychophysiology, 1974, 11, 336-345.

A sequential blanking paradigm was used to determine the effects of more intense, later appearing, stimuli upon the visual evoked potential (VEP) to earlier appearing stimuli. In sequential blanking the presentation of a sequence of visual stimuli at certain rates, and in certain orders, results in the perceptual blanking of approximately one-half of the stimuli. The precise timing and location requirements for this effect are conveniently produced with a digital computer and associated cathode ray tube display.

Further evidence was found for the inhibiting effect of later occurring (more intense) stimuli on the VEP response to earlier occurring (less intense) stimuli. This effect revealed itself in the delayed appearance of the major components of the VEP. In addition, it was found that the amount of delay was related to the ratio of the intensity difference between the earlier (blanked) and later occurring (blanking) stimuli, i.e., the greater the intensity difference between them the greater the temporal displacement produced in the VEP components.

- 22 Angel, A. The central control of sensory transmission and its possible relation to reaction time. Acta Psychologica, 1969, 30, 339-357.

It is shown that the amount of information reaching the cerebral cortex after the second of a pair of equal intensity stimuli applied to the same peripheral locus and in the same sensory modality varies inversely with the stimulus interval between the stimuli. For a simple stimulus activated task the reaction time can be related to the information reaching the cerebral cortex by the equation: $\log M = k_1 + k_2 (RT-L)$. Where $\log M$ is the psychological magnitude of the stimulus and k_1 and k_2 are constants, RT is the reaction time and L is the latency of the cerebral response evoked by the stimulus in the primary cortical receiving area.

- 23 Angiboust, R., & Gouars, M. Tentative d'évaluation de l'efficacité opérationnelle du personnel de l'aéronautique militaire au cours de veille's nocturnes. [Attempted evaluation of the operational efficiency of military aviation personnel during a night's watch.] In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

Performance impairment is correlated with a lowering of the arousal level as assessed by physiological variables (EEG and heart rate). The impairment is more pronounced when the task is carried out late in the night.

A two hours sleep period taken before a work session held in the second half of the night can raise the levels of both arousal and performance almost to those observed during the daytime.

Oxygen breathing has no noticeable effect either on performance or on the arousal level.

- 24 Anliker, J. Variations in alpha voltage of the electroencephalogram and time perception. Science, 1963, 140, 1307-1309.

Human subjects were instructed to respond regularly at 3-second intervals while their brain waves were recorded and analyzed. When subjects were alert the time between two successive responses did not vary greatly; however, as subjects became increasingly drowsy these times lengthened and the mean voltage of the peak alpha frequency decreased.

- 25 Anthony, B. J., & Putnam, L. E. P3 latency as a function of encoding speed. Psychophysiology, 1977, 14, 78. (Abstract)

Interest in the averaged evoked potential (AEP) arises from the assumption that its form over time represents neurological events relating to the sequence of sensory information processing. P3, the late positive wave of the AEP, has been broadly implicated in later stages of processing because of its insensitivity to physical parameters of the stimulus and susceptibility to influence from psychological variables such as attention. Posner et al. (1973) have suggested that P3 represents conscious operations occurring after the stimulus has contacted relevant representations in memory. To investigate this link, visual evoked responses (VERs) were recorded during a letter matching task and compared to reaction time (RT), which had been shown to vary systematically with the extent of encoding required for accurate performance.

Each of 8 subjects performed 192 match-mismatch RT judgments about two tachistoscopically presented letters occurring 1 sec apart. Each subject served in three different conditions distinguished by the instructed criterion defining a match: (1) PI (physical identity, e.g., AA), (2) NI (name identity, e.g., Aa), and (3) CI (category identity, both vowels or both consonants). EEG was recorded from a vertex lead and averaged for 1 sec from the onset of the second letter. Six VERs were obtained from each subject, corresponding to each type of match within a condition, i.e., physical matches in all conditions, name matches in NI and CI, and category matches only in CI.

RT data revealed that, within a condition, name matches were reported slower than physical matches but faster than category matches. P3 latency mirrored these graded changes in RT, increasing with the amount of encoding required before a decision. Moreover, correlations between RT and P3 latency were significant both across and within subjects. Results strongly suggest that P3 is associated with a stage of processing which occurs after memory registration and is closely related to response execution.

- 26 Antropov, G. A., Paltsev, P., & Maltseva, O. M. Fiziologo gigieniceskaja harakteristika truda operatorov pul'tov upravlenija elektrostancii blocnogo tipa. [Characteristics of work in modern power stations considered from the physiological and occupational health viewpoint.] Gigiena Truda i Professional'nye Zabolevanija, 1969, 13, 10-13.

Physio-hygienic investigations into work conditions of operators at the main and block control panels of power stations were carried out. At the main power station panel these were found to be close to comfortable, whereas in the premises of block control panels somewhat elevated air temperature and noise levels were recorded. The operators spend most of their working time in watching indications of instruments, transmission and reception of information over the phone and in keeping logs. Physiological examinations evidenced abated state of alertness during working hours, somewhat decreased tolerance of static boosting, elevated pulse rate at the beginning and at the end of the shift. Regular breaks in the work with on the job physical exercises, improvement of work conditions at the block control panels and introduction of shift alternation every 5-7 days, preceded by 2-3 days of rest, are recommended to keep up efficiency of control-panel operators.

- 27 Artem'eva, E. Y., & Khomskaya, E. D. Izmeneniya asimmetrii voln EEG pri razlichnykh funktsional'nykh sostoyaniyakh v norme. [Changes in the asymmetry of EEG waves in different functional states of normal subjects.] Voprosy Psikhologii, 1966, 3, 74-84.

Periodic oscillations in the asymmetry of the ascending and descending portions of alpha waves with invariant periods were observed in normal Ss. The oscillatory period does not depend upon the average level of asymmetry. As the functional state of the S changes (as during problem solving, fatigue, falling asleep, etc.), changes in asymmetry precede any visually detectable changes in the alpha rhythm. When intermittent auditory stimuli are presented, changes in alpha asymmetry occur only during the presentation of the 1st 1/2 of the stimuli, disappear later, and reappear when S is instructed to count the signals.

- 28 Aschoff, J., Giedke, H., Poppel, E., & Wever, R. The influence of sleep-interruption and of sleep-deprivation on circadian rhythms in human performance. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

This report describes a series of studies that relate changes in performance on such tasks as reaction-time, computation, concentration, etc. to changes in physiological variables (rectal temperature and urinary excretion of potassium, 17-hydroxycorticosteroids and catecholamines) as a function of circadian rhythms.

- 29 Auffret, R., Seris, H., Berthoz, A., & Fatras, B. Measuring perceptual load by cardiac rhythm variability. Ergonomics, 1968, 11, 85. (Abstract)

The variability of the cardiac rhythm was measured in two configurations: laboratory experimentation during compensatory tracking; in flight tests with a visor for instrument landing. In both configurations the variability is reduced and no connection with the cardiac frequency can be established. Different methods of calculation and of presentation of the results are shown.

B

- 30 Baker, C. H., O'Hanlon, J. F., Earl, W. K., Buckner, D. N., & Abrams, C. Human monitoring performance (750-F). Goleta, CA: Human Factors Research, Inc., August 1970. (NTIS No. AD-711350)

The two general purposes of the research were: (1) to increase knowledge of the relations between psychological and physiological variables and human monitoring performance, with the aim that such an increase would have practical implications for the many situations in Naval operations that require operators to remain alert over extended vigils; and (2) to investigate display design variables and concepts that might enhance human monitoring performance.

This report contains brief summaries of the work done under the contract and the technical reports.

- 31 Baker, G., & Franken, R. Effects of stimulus size, brightness and complexity upon EEG desynchronization. Psychonomic Science, 1967, 7, 289-290.

Measures of duration of EEG desynchronization were taken while Ss were exposed to a series of slides varying in complexity as well as size and brightness. There was a positive relation between duration of EEG desynchronization and level of complexity but no effect due to size or brightness. Significant habituation to temporal as well as spatial aspects of complexity were observed.

- 32 Barlow, J. S. Some statistical characteristics of electrocortical activity in relation to visual-oculomotor tracking in man. Boletin del Instituto de Estudios Medicos y Biologicos, 1963, 21, 497-518.

Detailed analyses of several aspects of visual-oculomotor tracking of a spot of light on an oscilloscope screen shifted vertically at predictable and unpredictable intervals between two alternate positions have been carried out for three subjects. Simultaneous recordings onto magnetic tape of the tracking signal, the position of the eyes (monitored electro-oculographically), and the midline parieto-occipital EEG were analyzed with the aid of a multi-purpose two-channel analog computer. The analyses included: histograms of oculomotor reaction times, average response type computations of stimulus-locked and oculomotor-response-locked activity in the EEG (for which the term "lambda response" is used) and amplitude histograms of the EEGs at various times with respect to the stimulus and with respect to the oculomotor response.

Responses evoked by the stimulus, and by the subsequent shift in position of the eyes which constituted oculomotor response, were clearly separable by the appropriate averaging technique, the clearest separation being obtained for the subject having the greatest variability of oculomotor-reaction times. No evidence was found to suggest that the occurrence of oculomotor responses was phased with respect to rhythmic components in the parieto-occipital EEG, but minimal evidence, for one subject, was found which suggested a quantization of reaction times.

33 Barlow, J. S. Evoked responses in relation to visual perception and oculomotor reaction times in man. Annals of the New York Academy of Science, 1964, 112, 432-467.

In separate psychophysical experiments with some subjects, an attempt was made to determine, by indirect means, the approximate time interval for subjective perception of the stimuli, and for subjective perception of eye movements, for comparison with the latencies of various components of the parieto-occipital evoked responses.

Potentials evoked by the shifting spot of light were generally appreciably smaller, and greater in latency, than those evoked by bright flashes of light with the eyes closed, but the amplitude of certain components of the former (i.e., those with an onset at approximately 80-90 msec.) was clearly increased during tracking for some subjects, an effect that may have been due to the fact that the fovea of the retina was more frequently stimulated during tracking than when the eyes were maintained fixed. Consideration of the latencies of these components suggests that they may represent nonspecific rather than specific evoked responses in the visual system. Comparison of averages of EEG responses with those of EOG responses established that the above-mentioned components appearing during tracking did not represent the electrical field, at the parieto-occipital scalp electrodes, of the EOG potentials, although the amplitude of the latter at their source is much larger than that of the EEG potentials. Suggestive, but not conclusive, evidence for different forms of evoked responses for different directions of spot-shifts were obtained for some subjects.

A comparison, for one subject, of the results of the psychophysical experiments with those of the electrophysiological recordings provided some tentative evidence that the subjective perception of spot-shifts takes place, on the average, rather early (i.e., within 40 msec or less), a finding that suggests that visual perception of simple stimuli may be more closely related to specific visual pathways than to nonspecific ones. Only minimal evidence of an early, specific response was, however, obtained in the present series of experiments for spot-shifts as visual stimuli. It appears probable that a component appearing in the averaged parieto-occipital EEG response at a constant interval of time after the mean oculomotor reaction time represents the same basic phenomenon as that of the "lambda waves" following eye movements which have been described previously by other workers.

The findings from these electrophysiological and psychophysical experiments are discussed in relation to the question of quantization of time in the nervous system.

- 34** Barlow, J. S., & Ciganek, L. Lambda responses in relation to visual evoked responses in man. Electroencephalography and Clinical Neurophysiology, 1969, 26, 183-192.

1. In five normal subjects, midline parieto-occipital averaged EEG responses to shifts of the image of a spot of light from an oscilloscope screen on the retina were examined. The shifts of the position of the image on the retina were accomplished in two different ways: (a) by alternation of the direction of visual gaze, the position of the spot on the oscilloscope screen remaining unchanged (lambda responses), and (b) by alternation of the position of the spot on the oscilloscope screen, the direction of gaze remaining fixed (ordinary visual evoked responses). In order to insure comparability of the time course of retinal stimulation, the motion of the spot on the oscilloscope screen was controlled by a previously recorded electro-oculogram from the same subject. Additional recordings under several different experimental conditions were also included, for fuller definition of the phenomena under study.

2. In no case were the EEG responses for the two conditions identical, although for some subjects there was a marked similarity for responses resulting from a shift of the image of the spot from the periphery onto the fovea of the retina; for the reverse, wave forms and similarities were much less well defined.

3. In all instances of voluntary eye movements (i.e., alternation of gaze between bright and dim, or between dim and dim spots, in total darkness, or when the spot on the oscilloscope screen moved congruently with the eyes so that its image remained constantly on the fovea), an EEG potential change was evident, the onset of which preceded the initiation of eye movements by 150-200 msec; this anticipatory potential change was absent for the involuntary or compensatory eye movements occurring upon passive turning of the head.

4. These findings are discussed in relation to the phenomena of expectancy waves, decreases in the amplitude of evoked responses and increases in visual threshold associated with eye movements, and in relation to mechanisms of supposed perceptual blanking associated with eye movements.

- 35** Barnett, T. P., Johnson, L. C., Naitoh, P., Hicks, N., & Nute, C. Bispectrum analysis of electroencephalogram signals during waking and sleeping. Science, 1971, 172, 401-402.

The degree of interaction of component waves making up a single electroencephalogram trace was strongly correlated with alpha activity, lead placement, and state of consciousness. Significant quadratic coupling of the waves was found only for awake subjects with high alpha activity. For these subjects about 50 percent of beta activity can be attributed to harmonic coupling with the alpha peak. During sleep, the degree of interaction was of borderline significance and did not follow a consistent pattern with respect to subject, frequency, state, or lead.

- 36 Barratt, E. S. Intra-individual variability of performance ANS and psychometric correlates. Texas Reports on Biology and Medicine, 1963, 21, 496-504.

The general purpose of this study was to relate variability of ANS measures to intra-individual variability of performance (IIVP) on a series of unrelated tasks. The results indicated a significant positive relationship between ANS variability and IIVP for simple tapping, CFF, auditory jump reaction time, visual jump reaction time, and simple arithmetic problems. A psychometric measure of impulsiveness was significantly related to both variability of ANS measures and to IIVP.

- 37 Bartenwerfer, H. Einige praktische Konsequenzen aus der Aktivierungstheorie. [Practical evaluation of activation theory.] Zeitschrift für Experimentelle und Angewandte Psychologie, 1969, 16, 195-222.

After a theoretical consideration of general (unspecific) central activation (GCA) four methods are described for measuring mean degrees of GCA for groups of persons in fixed situations (i.e. working activities). The degree of GCA varies on an interval scale with a zero point at deep dreamless sleep.

Two methods are based on the scaling of statements about "inner (nonmuscular) tension". The other two methods consist of the measurement of a certain part of heart rate changes. In the fields studied up to now the results of all four methods are in linear correlation both with one another and with scaled ratings of groups of experts.

The methods have been developed with regard to practical applicability in school and industry. Validity studies have shown the practical applicability and validity even under unfavorable circumstances.

- 38 Bartley, S. H., & Simonson, E. Use of visual methods for measurement of general fatigue. In E. Simonson & P. C. Weiser (Eds.), Psychological aspects and physiological correlates of work and fatigue. Springfield, IL: C. C. Thomas, 1976.

Several attempts to study the more general effect of visual work on nonvisual physiological functions, such as V_{O_2} , heart rate or muscle tension, have been discussed in Chapter 6, "Visual Fatigue." Visual tests have also been used as an index of general, mainly CNS, fatigue in work without appreciable visual effort. Thus, visual receptors and other physiological functions appear to be linked by a mutual feedback in the response to work and fatigue.

- 39 Bartoshuk, A. K. Electromyographic gradients as indicants of motivation. Canadian Journal of Psychology, 1955, 9, 215-230.

Previous electromyographic (EMG) studies of mirror tracing and attentive listening reported EMG gradients, that is, a progressive increase in muscle potentials from the beginning to the completion of a given psychological task. Results on completed and interrupted tasks suggested that the slope of EMG gradients may be indicative of motivation. If this were true, gradient slope should be directly related to performance speed and accuracy. This experimental hypothesis was tested in the present EMG study of 25 subjects through 24 trials of mirror tracing.

An analysis of variance revealed that significant differences in gradient slope could be attributed to intermuscle differences, and to differences between subjects for each muscle. With subjects equated for practice, gradient slope (especially for right forearm extensor) was directly related to speed and accuracy of performance. Moreover, intertrial changes in gradient slope were related to rate of performance improvement. Evidence from other studies reviewed showed that gradient slope was also related to reported interest in the task, and to magnitude of incentives offered for good performance. These results support the hypothesis that gradient slope is a direct function of strength of motivation to perform a given task.

- 40 Bathien, N. Reflexes spinaux chez l'homme et niveaux d'attention. [Spinal reflexes and attention level in man.] Electroencephalography and Clinical Neurophysiology, 1971, 30, 32-37.

A statistical analysis of the results was carried out using both parametric and nonparametric techniques. In the first case the student t test, and in the second case, the Wilcoxon test and the Friedman analysis of variance by rank, were used.

The IBM test did not significantly modify any of the reflexes; the Epel test only facilitated the TSol, whereas the Mult test did so for both the TSol and TBI. The Add test produced in addition an inhibition of the IIIBi, and both the XY and the Lett tests significantly modified all the reflexes.

It can be concluded that the facilitation of γ motoneurons is obtained for a low level of activation, that an inhibition of the flexor reflex afferents is obtained for a higher level and that facilitation of the H reflex, produced by the highest levels of activation, indicates the lower sensibility of α motoneurons to reticular discharge.

- 41 Bathien, N., Bertrand, F., Gautier, H., Hugelin, A., & Vincent, J. Sensibilite comparee de tests sensitifs, moteurs, vegetatifs et respiratoires au cours de l'attention. [Comparative sensitivity of sensory, motor, vegetative and respiratory tests to levels of attention.] Journal de Physiologie (Paris), 1967, 59, 342. (Abstract)

As the intensity of attention diminished, an identical sequential decrease of effects, characterized by a reduction in the number of parameters modified in a significant fashion, was observed in the same subject and from one subject to another. In the 12 experiments retained, a decreasing sensitivity to attention was found; the observed effects going from maximum to minimum were as follows: (1) reduction in duration of expiration; (2) inhibition of evoked potentials; (3) heart rate acceleration; (4) increase in inspiration slope; (5) facilitation of the saphena-bicipital reflex; (6) augmentation of electrodermal activity; (7) increase in muscle tone; and (8) decrease of flow volume.

- 42 Bathien, N., & Hugelin, A. Reflexes monosynaptiques et polysynaptiques de l'homme au cours de l'attention. [Monosynaptic and polysynaptic reflexes in man during attention.] Electroencephalography and Clinical Neurophysiology, 1969, 26, 604-612.

Extension and flexion monosynaptic reflexes and flexion polysynaptic reflexes were studied during activation produced by two tests requiring the sustained attention of the subject. The psychological tests used were sufficiently difficult to produce, in all the subjects, significant variations in the respiration and heart rates and in the amplitude of the evoked potentials in the cortex.

1. The soleus tendon reflex was increased considerably.

2. A comparison of the monosynaptic responses of the soleus produced either by cutaneous stimulation of the group Ia afferent fibres (H reflex) or by percussion of Achilles' tendon (tendon reflex), did not reveal large differences in the responses. The effect contrasted with the modifications observed in the course of the Jendrassik manoeuvre (clenching the fist) which modified little the H reflex but increased considerably the ankle jerk and seemed to act preferentially on the fusimotor system.

3. The tendon reflex of the biceps femoris (flexor) was increased in all cases.

4. The polysynaptic reflex (of flexion) of the biceps produced by cutaneous stimulation of the sural group II afferents was significantly increased in all cases.

5. On the contrary, the polysynaptic reflex of the biceps, produced by stimulation of the group III afferents of this nerve, was inhibited.

6. According to the type of test used and the reflexes studied, variations were observed within the same subject and between subjects in the strength of the responses. Nevertheless, the results obtained were extremely significant statistically.

7. The simultaneous recording of the different reflexes studied confirmed the stereotyped motor effects of attention. The stereotyping is identical to that observed in animals when the supra-bulbar reticular formation is stimulated.

- 43 Bathien, N., & Morin, C. Variations comparees des reflexes spinaux au cours de l'attention intensive et selective. [Comparing variations of spinal reflexes during intensive and selective attention.] Physiology & Behavior, 1972, 9, 533-538.

Studied monosynaptic and polysynaptic spinal reflexes in 8 male and 2 female students during attention tests. The tests explored 2 aspects of attention: (a) during selective attention tests, S had to pick out, in a limited time, significant signals from among other signals; (b) during intensive attention tests, S had to handle in a given length of time a certain number of signals which were all significant. The mean effect and the statistical variation of the reflexes as a function of time was then calculated. Two different types of motor responses were observed. The intensive attention tests facilitated the monosynaptic extensor and flexor reflexes and inhibited the polysynaptic flexor reflex. This stereotyped motor response was due to an activation of the reticular formation. The opposite effect was obtained during the selective attention tests. This response is thought to be part of an activating reaction in which other nonspecific encephalic structures are implicated.

- 44 Baumler, G., & Klausnitzer, J. Zur EEG-symptomatik von mentalen blockierungen. [EEG changes during mental blocking.] Zeitschrift für Experimentelle und Angewandte Psychologie, 1972, 19, 196-225.

Electroencephalograms (EEGs) accompanying mental blockings in the course of a serial reaction activity lasting for 28 minutes were studied. Fifteen students showing normal EEGs acted as subjects. Twelve further students having irregular pathological EEGs were excluded from the analysis of data.

Bipolar EEG records from the right occipital lobe were studied with the conventional visual method. Pulse frequency and various criteria of reaction performance were also considered.

The most important results can be formulated as follows:

(a) The EEGs accompanying mental blockings show characteristics which are peculiar for increased mental activity, such as after prolonged mental work, as compared to the EEGs accompanying the reactions uninterrupted by mental block.

(b) Just before the occurrence of a mental block, a small increase in the beta activity and a large increase in the theta activity is registered. Besides, the wave index and the amplitudes increase. The alpha activity decreases largely.

(c) During, and particularly just after the occurrence of a mental block the beta activity remains increased, and the alpha waves, theta waves, wave index, and amplitudes decrease. This phenomenon was considered to indicate the increase of arousal and mental activity in the subjects, and to be associated with the feelings of frustration, loss of orientation, and reactive increase of effort.

Besides, the mental blocks seem to suffer certain changes during the course of continued mental activity. As the time advances, disactivation or fatigue seem to play a greater role as causes of mental blocking.

On the whole, the results confirm the hypothesis postulated by various authors that mental blocking is at least partly caused by physiological disactivation.

- 45 Beatty, J., Greenberg, A., Diebler, W., & O'Hanlon, J. Operant control of occipital theta rhythm affects performance in a radar monitoring task. Science, 1974, 183, 871-873.

Detection efficiency of human observers deteriorates rapidly in monotonous monitoring tasks; this effect (the vigilance decrement) has been associated with increased theta band activity in the electroencephalogram. Suppression of theta activity by operant methods enhances monitoring efficiency, whereas theta augmentation further degrades task performance. These results demonstrate a lawful relationship between operantly regulated cortical activity and behavior in man.

- 46 Beck, E. C. Electrophysiology and behavior. Annual Review of Psychology, 1975, 26, 233-262.

Among other topics, this article reviews the literature on: Contingent Negative Variation (CNV); Evoked Responses and Attention, Habituation and Selective Attention; Evoked Responses and Information Delivery—Stimulus Uncertainty, the P3 Wave; Psychological Variables and the CNV; and, Evoked Responses and Sleep, Anesthesia, Hypnosis, and altered consciousness.

- 47 Beck, E. C., Dustman, R. E., & Sakai, M. Electrophysiological correlates of selective attention. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

Why should electrocortical changes with levels of attention be most evident in the minor hemisphere? We honestly do not know. However, recent experiments in our laboratory have repeatedly implicated the right parietal area in findings that may be closely related to the neurophysiology of attention. Rhodes comparing the visual evoked responses of 20 bright children (group mean IQ of 130) with an age matched group of 20 dull children (mean IQ of 79) found one of the main differences in their evoked responses was the tendency of the bright child to have hemispheric asymmetry with much larger evoked responses recorded from right parietal scalp. In the dull child no hemispheric differences were apparent. Bigum (1966) doing his dissertation in our laboratory with mongoloid children has reported the same situation when the mongoloid child is compared with an age matched normal child. All but two of 24 normal children demonstrated hemispheric asymmetries in their evoked responses with the larger response occurring in the right hemisphere, particularly noticeable in the parietal area. The mongoloid children showed no hemispheric differences.

We feel a common denominator of these later studies may be the level of attentiveness, namely, normal and bright children are by definition more attentive than dull or mongoloid youngsters; alcohol is a depressant and level of attention is probably reduced after ingestion; during counting or conditioning the level of attention is most probably increased. In all these instances there is a marked change in amplitude and stability of the evoked response recorded from right parietal scalp in the same direction as the level of attention. The findings are clear and reliable but the explanation is obscure.

- 48 Becker, W., Hoehne, O., Iwase, K., & Kornhuber, H. H. Cerebral and ocular muscle potentials preceding voluntary eye movements in man. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 99-104.

After the discovery (Kornhuber and Deecke 1964) of the slow negativity preceding voluntary movements of the limbs (Bereitschaftspotential (BP) or readiness potential (RP)), our laboratory became interested in voluntary saccadic eye movements, and we were able to demonstrate that eye movements, too, are preceded by a Bereitschaftspotential (Becker et al. 1968). The comparison of eye movements with movements of the limbs gained particular interest after the finding of two other potentials that precede voluntary limb movements, namely the pre-motion positivity (PMP) and the motor potential (MP) (Deecke et al. 1969). This report is concerned with the occurrence of PMP and MP in relation to saccadic eye movements.

- 49 Becker-Carus, C. Electrophysiological correlates of a cognitive personality variable (automatization). Archiv fur Psychologie, 1971, 123, 171-185.

Studied the correlation between the performance on vigilance and cognitive tasks with alpha and beta activity of the EEG. Ten male and 9 female university students were given verbal and nonverbal tests of repeated subtraction and asked to detect which of 3 spots were lighted on a random basis over a 30 min period. During this time the EEG was recorded across leads T₅-O₁. The degree of automatization was measured with the Stroop "reading of color names" and the Embedded Figures Test. Less alpha activity was found in Ss showing strong automatization, and this in turn was negatively correlated ($p < .05$) with the number of subtractions begun and the number of correct detections made during vigilance. Correlations between arithmetic performance and EEG activity were insignificant, but slow alpha frequencies tended to predominate in highly vigilant Ss.

- 50 Becker-Carus, C. Interindividuelle elektrophysiologische Unterschiede als mogliche Leistungspradiktoren. [Interindividual electrophysiological differences as possible predictors of performance.] Unpublished manuscript, 1971. (Available from Dr. C. Becker-Carus, Psychologisches Institut der Universitat Tubingen, 74 Tubingen-1, Friedrichstr. 2., West Germany.)

Among the findings reported in this study was a significant negative correlation ($R = -.71$) between the amount of alpha activity and adequacy of performance in a vigilance-like task.

- 51 Becker-Carus, C. Physiologische Korrelate psychischer Variablen. [Physiological correlates of psychic variables.] Archiv fur Psychologie, 1971, 123, 65-82.

Presents a comprehensive review of recent psychophysiological literature. The relationships of the GSR, EEG, EKG, and EMG to performance on vigilance tasks, learning, sleeping and wakefulness, and various personality characteristics are discussed. H. J. Eysenck's theory of cortical excitability on introversion and extroversion is emphasized. Despite the diversity of physiological and psychological relationships, it is suggested that an inverted-U function describes the relation between performance and emotional excitability, while a curvilinear, or possibly a linear, relationship exists between performance and stressful tasks. (English abstract)

- 52** Becker-Carus, C. Relationships between EEG, personality and vigilance. Electroencephalography & Clinical Neurophysiology, 1971, 30, 519-526.

Investigated the dependence of alpha frequencies on vigilance performance and rigidity, extroversion, and neurotic tendency in an experiment with 36 undergraduates. The EEG was recorded from bipolar derivations during resting and task periods. Results indicate that (a) good vigilance correlated positively with low and negatively with high alpha frequencies; (b) rigidity correlated negatively with low and positively with high alpha frequencies; (c) neurotic tendency correlated positively with intermediate alpha frequencies during the vigilance task, and negatively during the resting period prior to the task; and (d) poor performance on the arithmetic tasks correlated negatively with the alpha index during the resting stages, and positively with the low alpha frequencies during the vigilance task. Results suggest that good vigilance was associated with lower alpha frequencies and poor vigilance with higher ones. Rigidity appeared to be associated with high alpha frequencies and poor performance. When neurotic tendency was high, performance of the vigilance task caused an increase rather than a decrease in 10-11 cps waves.

- 53** Becker-Carus, C., & Heinemann, U. Hemisphärische Dominanz, Synchronisation und individuelle Frequenzklassenbevorzugung bei wiederholten Testaufgaben (FRT) und die Frage der Reliabilität. [Hemispheric dominance, synchronization and individual EEG frequency-bandwidth characteristics while repeating test items and the question of reliability.] In Die Quantifizierung des Elektroencephalograms, Symposium der Arbeitsgemeinschaft für Methodik in der Elektroencephalographie, Jönköping (Schweiz), 1973.

In accordance with the assumption, that special parameters of EEG-activity in specified performance situations are relevant for individual differences in personality as well as in achievement, a computer program was developed and applied to investigate systematic relationships between different EEG-parameters and the individual achieved performance in a frequently repeated short time memory test. Under investigation was a group of 30 male subjects with the age of 22 to 30 years. Besides questionnaire tests of extraversion, neuroticism and rigidity they were tested for achievement motivation and anxiety. The experimental program including phases of relaxation, consists of alternate presentation and performance of the figure-reconstruction-test (FRT) with a duration of 80 min in total and a subsequent vigilance task.

The EEG analysis performed automatically by the developed program at an IBM 1130 computer results in separated scores of frequency and amplitude distributions of 2 cpm classes, clinical EEG areas as well as hemispheric dominance and synchronisation. After conversion into digital values (4 msec steps) the program searches for relevant recording periods (30 sec) marked by trigger. A digital filter, now, smooths the curves to exclude noise (muscle, 50 c/sec). Next follows determination of the potential peaks (minima-maxima) and calculation of differences of peak times. From this (1) frequency classes of 2 c/sec were derived and (2) differences of peak times between corresponding left and right alpha waves and (3) mean values for peak differences were calculated.

Results showed (1) good retest reliability for frequency class preferences with special tasks; (2) interhemispheric synchrony correlates highly with vigilance latency, achievement-motivation and anxiety. Further analysis revealed that a time delay in synchrony only up to 4 msec (called "actual synchrony") is essential to prediction of blocking achievement anxiety.

- 54 Becker-Carus, C., Lanc, O., & Ritter, M. Elektroenzephalogramm, galvanische hautreaktion und persönlichkeits-variablen: Ein beitrag zur aktivations-forschung. [Electroencephalogram, GSR and personality variables: A contribution to activation research.] 27th Congress of the German Psychological Association, Kiel, 1970.

Twenty Ss were tested under the conditions of relaxation, problems of varying difficulty and, again relaxation. Results: There are high correlations for both baseline skin resistance and the evoked GSR's between experimental conditions. There were no consistent correlations between the EEG and the GSR. During relaxation, EEG's of high frequency correlated positively with the maximal evoked GSR amplitudes and with the first Halbbreite. In relaxation, EEG's of slow frequency correlated negatively with changing GSR in problem situations (arithmetic), and positively with the rigidity score. High baseline resistance in both relaxation and expectation of problems correlates negatively with extraversion and positively with neurotic tendency.

- 55 Becker, W., Iwase, K., Jurgens, R., & Kornhuber, H. H. Bereitschaftspotential preceding voluntary slow and rapid hand movements. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

The Bereitschaftspotential (BP) preceding voluntary self-paced slow and rapid movements of the hand was investigated. Preceding slow smooth movements the BP starts 0.5 sec earlier and tends to have larger amplitudes than for rapid ballistic movements. If the movements are not self-paced, but elicited by an auditory signal, the RT to the signal is 100 msec longer for slow movements than for rapid ones. It is suggested that these differences reflect a different central organization of slow and rapid voluntary movements.

- 56 Beckman, F. H., & Stein, M. I. A note on the relationship between percent alpha time and efficiency in problem solving. Journal of Psychology, 1961, 51, 169-172.

The problem-solving efficiency scores ranged from 4 to 104 with a mean of 56.38. The percent alpha time ranged from 0 to 95 with a mean of 40.91. The rank order correlation (corrected for ties) between problem-solving efficiency and percent alpha time was $-.47$ ($p < .01$, one-tailed). The more efficient problem solvers tended to have less alpha in their resting EEG's than did the less efficient subjects. Since our total population of subjects included individuals that differed widely in age (18-41) it should also be noted that age did not correlate significantly with either the EEG data ($\rho = .27$) or the efficiency score ($\rho = -.28$). It is beyond the scope of this note to present neurophysiological interpretations of the data. However, there is general agreement in the literature that suppression of alpha in the normal subject is related to a state of "arousal" or increased attention to external and possibly internal stimuli (Jasper, 1958). We might speculate, therefore, that the more efficient problem solvers in this experiment may be operating with a generally higher level of "cortical excitation" and are consequently in a state of readiness to integrate external information or information which is "stored" in the cortex.

- 57 Begleiter, H., & Platz, A. Cortical evoked potentials to semantic stimuli. Psychophysiology, 1969, 6, 91-100.

The influence of affective meaning on the photically evoked response was studied in male college students. Three sets of stimuli were used: taboo words, neutral words, and blank flashes. Two blocks of trials were run for each stimulus, one in which the S responded by calling the stimulus presented, and a second in which the S was not required to respond.

The late components of the evoked potential were significantly related to both the stimulus and response conditions. Amplitude 2 was larger for the taboo words than for either the neutral words or the blank flash. The taboo words had a significantly greater amplitude 3 than neutral words, and both sets of words had higher amplitude 3 than the blank flash. The stimulus effect was discussed in terms of the possible influence of anatomical structures involved in emotional behavior on the visual evoked response. The response effect was felt to be the result of the increased attention required under the response condition.

- 58 Begleiter, H., & Porjesz, B. Evoked brain potentials as indicators of decision-making. Science, 1975, 187, 754-755.

The effects of decision-making processes on evoked brain potentials recorded at the vertex were studied in human subjects. Significantly different visual evoked potentials to the same physical stimulus were obtained in trials that resulted in different behavioral decisions. The results suggest that certain characteristics of evoked potentials may perhaps be used as indicators of specific behavioral outcomes.

- 59 Beh, H. C., & Nix-James, D. R. The relationship between respiration phase and reaction time. Psychophysiology, 1974, 11, 400-402.

The relationship between phase of normal respiration and reaction time (RT) was studied. Ss were required to respond by pressing a switch each time a simple auditory signal was presented. Averages of response times were calculated for signals occurring during each of three identifiable phases of normal respiration. It was found that mean RT for signals presented during the inhalation phase of respiration was significantly less than for signals presented during either the exhalation phase or the pause between exhalation and inhalation.

- 60 Behnke, R. R. An exploratory study of relationship between galvanic skin response and information-gain (Doctoral dissertation, University of Kansas, 1966). Dissertation Abstracts, 1966, 27, 1953A-1954A. (University Microfilms No. 66-13, 014)

This study examined the relationship between the galvanic skin response and the ability of a subject to acquire new information. A three-phase procedure was employed in this experiment consisting of the pre-test, experimental treatment and post-test phases. In the pre-test phase, subjects took a short completion-type test of a general educational nature which consisted of 45 items. During the experimental treatment phase these same subjects listened to a tape recording of these same items with the missing information supplied. The galvanic skin response of each subject was recorded for each item. In the post-test phase, an identical form of the pre-test was administered to each subject to determine if the tape recorded material could be recalled. All three phases of the experiment were conducted in sound-treated rooms.

In testing for a significant relationship between galvanic skin response and information-gain these responses were paired for each item. This pairing resulted in four possible combinations: (1) the occurrence of galvanic skin response with information-gain; (2) the occurrence of galvanic skin response without information-gain; (3) the occurrence of information-gain without galvanic skin response; and (4) the occurrence of neither galvanic skin response nor information-gain.

A statistical comparison of galvanic skin response and information-gain for the test as a whole yielded a Chi square which was significant at the .01 level of confidence. In addition to this finding, it was noted that the strength of the statistical relationship between galvanic skin response and information-gain was a function of the difficulty level of the material. Items whose difficulty index fell within the middle range (.40-.60) showed significant Chi squares while the easy items and the difficult items did not. Contingency coefficients calculated for the significant items ranged between .471 and .544 with a median of .508. The maximum size which is possible for this coefficient in a four-fold table is .707.

The relationship between the difficulty indices of the 45 items as calculated from the scores of subjects in the post-test phase and the difficulty indices of these same items as calculated from the scores of pilot-study subjects was of interest. A Spearman Rank-Order Correlation Coefficient showed this relationship to be .914.

The major conclusion of this study was that the physiological responsiveness of a subject (insofar as it may be reflected in the galvanic skin response alone) was significantly related to his ability to provide correct responses on the post-test to those items which he was unable to answer correctly prior to the experimental treatment.

- 61 Beideman, L. R., & Stern, J. A. Onset and terminal orienting responses as a function of task demands. Psychophysiology, 1971, 8, 376-381.

The frequency of response and trials to habituation of the electrodermal onset and terminal orienting response were manipulated as a function of discrimination tasks involving either stimulus content (pitch) or duration. There were no significant differences between the groups on either measure for onset ORs; however, the duration task group demonstrated more TORs and required a greater number of trials to habituate than the content task group. The results, interpreted in terms of the development of cortical models, supported Stern's suggestion that OR and TOR habituation are related to the content and duration of the stimulus respectively.

- 62 Belanger, D. "Gradients" musculaires et processus mentaux superieurs. [Muscular gradients and higher mental processes.] Canadian Journal of Psychology, 1957, 11, 113-122.

Electromyographic techniques were used in this study to measure changes in muscular tension in the forearms of subjects engaged in perceptual-motor tasks of contrasted difficulty.

In Experiment I, 14 normal subjects were given the rapid discrimination test. This requires quick discrimination between circles of slightly varying size; S responds by pressing a button. All Ss showed a gradual increase of tension ("gradient") in the forearm muscles during the test series. Gradients appeared in both active and passive arms and were most marked in the extensor muscles.

Experiment II was carried out to determine whether these gradients could plausibly be attributed to the repeated finger-pressure movements, rather than to the difficulty of the perceptual task. Accordingly, the latter was reduced to the simple perception of clicks sounded at regular two-second intervals, the subject being required to press the button each time he heard a click. Under these control conditions there was no evidence of gradients in the muscles observed.

On the basis of these and previous findings the author concludes that the gradient phenomenon is related, not to the motor aspects of the task, but to its psychological difficulty. If the problem is too easy it induces only a low level of "arousal," and muscle-tension gradients are not observed. On the other hand, it seems clear from other investigations that if arousal is increased beyond a certain point (by external incentives, internal motivating conditions, task difficulty, etc.) the energy mobilized becomes uncontrollable, conceptual organization deteriorates, the reaction takes on an emotional character, and efficiency of performance is impaired.

Thus gradients of muscular tension, since they appear to correlate with arousal, become valuable indices of the smooth and efficient functioning of the higher mental processes. The required physiological link between central integrative activity and peripheral muscle tonus is suggested in Hebb's motivational theory.

- 63 Bell, C. R., & Provins, K. A. Relation between physiological responses to environmental heat and time judgements. Journal of Experimental Psychology, 1963, 66, 572-579.

In 3 experiments changes in the magnitude of estimations of standard intervals of 45 sec, 100 sec, 4 min, 9 min, and 13 min were examined when body temperature and pulse rates had been increased by exposure to high temperature environmental conditions. Three methods of estimation were used: counting at an estimated rate of 1 digit per second, verbal estimation of time passed in a given activity, and the productions of an interval named, but not demonstrated by E. No consistent relationship was found between changes in estimate size and changes in either body temperature or pulse rate. Wide inter-S variation was found in both direction and extent of change in estimate size with significant increases in body temperature and pulse rate.

- 64 Bell, C. R., Provins, K. A., & Hiorns, R. W. Visual and auditory vigilance during exposure to hot and humid conditions. Ergonomics, 1964, 7, 279-288.

The effect of exposure to climatic conditions ranging in severity from 29.5/24.5°C (85/76°F) db/wb to 63/47°C (145/117°F) db/wb on the performance of (1) a visual and (2) an auditory vigilance task was studied separately in 2 series of experiments on fit young men. Exposure time decreased with increasing climatic severity. When performance was examined in terms of the proportion of signals missed to signals given there was no evidence of a change in vigilance with different climatic conditions; but in both experimental series, a greater proportion of signals was missed as body (oral) temperature increased.

- 65 Bell, C. R., & Watts, A. J. Thermal limits for industrial workers. British Journal of Industrial Medicine, 1971, 28, 259-264.

The literature on relationships between man's comfort, efficiency, and physical well-being and the nature of his thermal working environment is diverse and highly specific. Industrial practice requires more general 'consensus' data on which to base reasonable recommendations for the establishment of thermal environmental limits. A series of three such limits is proposed which provide protection of the workers' comfort, efficiency, and physiological safety.

For sedentary workers it is suggested that in summer an upper limit of 21.8°C C.E.T. is advisable if not less than 80% of workers are to be free from discomfort. Against a similar criterion in winter a lower limit of 15.5°C C.E.T. is proposed. An extrapolation of data from laboratory to industrial work-places provides a suggested limit for efficiency at skilled tasks at 26.7°C C.E.T. Finally, a limit of environmental severity based upon an absence of severe physiological distress in 95% of exposed workers is proposed which varies with the age and physical fitness of the workers and the physical demands of the work they are called upon to perform.

- 66 Bena, E., Noskova, M., & Poche, V. Bewertung des vigilanzzustandes von lokführern von elektrischen und diesel-elektrischen lokomotiven mit hilfe der taglichen rhythmien der korper Temperatur, des blutdruckes, der puls frequenz und der excitationsschwelle des achilles-schennreflexes. [Use of body temperature, biorhythms, pulse frequency, blood pressure and achilles tendon threshold for evaluation of the degree of vigilance during train driving.] Proceedings of a Symposium on Ergonomics in Machine Design, jointly organized by the Czechoslovak Medical Society J. E. Purkyne and ILO, Prague, 2-7 October 1967, ILO, Geneva, 1969, 1, 291-300.

Factors in the load of vigilance: (1) attention to signals (long intervals between the signals or bad visibility). Without stimulation by the second engine driver vigilance lasts only for two to three hours. Independent driving should not exceed three to four hours. (2) Climate and monotonous cab noise (require suitable cab design). (3) Irregular cycles of shifts: shifts begin and end at all hours of the day and night. Thus the twenty-four hour rhythm of sleep and vigilance is broken into irregular fractions and the synchronisation between the brain cortex and autonomic nervous system, and hence body temperature, pulse frequency and blood pressure are disturbed. These factors are related to mental blocks during driving (accumulation of sleep debts). This may be tested for example during the second night of driving. The driver starts the evening already in the trophotropic stage, which imperils his vigilance more easily. The tests enable us to estimate the synchronisation of autonomic rhythms with the cortical function as it affects vigilant driving, and to make proposals concerning cycling of shifts.

- 67 Benson, A. J., Huddleston, J. H., & Rolfe, J. M. A psychophysiological study of compensatory tracking on a digital display. Human Factors, 1965, 7, 457-472.

Comparable performance on a compensatory tracking task was achieved with a purely digital altimeter display and with a combined digital and scale-and-pointer display. Performance of a subsidiary, light responding task was degraded significantly when the digital task was employed. In the presence of the subsidiary task a larger change was recorded in a number of physiological variables (heart rate, muscle activity, skin resistance and respiration) with the digital than with the counter-pointer display. Thus, both performance and physiological measures indicate that parity of performance on the primary task was achieved by increased "effort" when using the digital display.

- 68 Bergamini, L., & Bergamasco, B. Cortical evoked potentials in man. Springfield, IL: Charles C. Thomas, 1967.

After a critical review of available techniques, a summary of current knowledge on the average cortical evoked potential has been discussed based on data taken both from the literature and from personal observations in man.

Two main points emerge from this work: the first is that through the summation of cortical bioelectrical phenomena, evoked by sensory stimulations, a quantitative analysis is possible of events associated with human psychological behavior. Grey Walter's discovery of CNV is of basic importance for any student of psychological phenomena with a measuring approach.

The possibility of physiological investigations of certain phenomena such as the expectation of an event, the degree of expectation, and its variations in relation to social and other psychological aspects will open entirely new fields of research for psychophysicologists, psychopharmacologists, and psychiatrists.

The second point is related to the use of evoked responses in clinical neurological problems, where this technique may help in the study of a lesion and its site and may be of practical value in the study of a variety of physiopathological conditions.

This book is addressed to the clinical neurophysiologist and we hope that he may find in our work some helpful data.

- 69 Bergamini, L., Bergamasco, B., & Mombelli, A. M. Etude sur les elements qui influencent la variabilite des responses corticales evoquees visuelles chez l'homme. [Study of factors effecting variability of human visual evoked responses.] Electrodiagnostic-Electrotherapie, 1966, 1, 22-33.

The authors have studied the variations of human visual evoked potentials recorded intracranially, caused by differences in pupillary diameter and by different states of EEG synchronization-desynchronization in relation to habituation, attention and distraction.

The following results were obtained:

(1) Variations in pupil diameter affect the amplitude and latency of the visual evoked potential; for moving pupils, the amplitude of the ER is greater with dilated pupils, and even greater with contracted pupils (the inverse is true of latency).

(2) Habituation, the progressive decrease of ERs during prolonged and monotonous stimulation, does not occur if pupillary diameter is not changed due to the light stimulation.

(3) EEG desynchronization causes a decrease in the ER, particularly the early component; it disappears entirely at about the time desynchronization reaches its maximum.

(4) Attention and distraction studies of Ss with dilated pupils showed a decrease of the visual evoked potential due to the EEG desynchronization caused by these phenomena.

It was concluded, in reviewing these results that changes in pupillary diameter and changes in cortical activation level which affect the amplitude of the visual evoked potential, should be considered as new parameters in the study of dynamic central nervous activity.

- 70 Berger, R. J., & Meier, G. W. An automatic analyzer of states of vigilance. Psychophysiology, 1966, 2, 141-145.

An assemblage of relay-operated, commercially available programming modules is described. It is capable of discriminating among the states of vigilance—wakefulness (W); high-voltage, slow-wave sleep (HVS); and low-voltage, fast-wave sleep (LVF)—and it requires information from only the nuchal electromyogram (EMG) and the electrooculogram (EOG).

- 71 Berger, R. J., & Scott, T. D. Increased accuracy of binocular depth perception following REM sleep periods. Psychophysiology, 1971, 8, 763-768.

It has been proposed that REM sleep maintains facilitation of coordinated eye movements necessary for accurate binocular depth perception (Berger, 1969). This experiment confirmed the prediction that binocular depth perception would be more accurate at the ends of REM periods than at their onsets. Eight male subjects were studied during 4 non-consecutive nights of sleep. Accuracy of binocular and monocular depth perception were measured with different apparatus in the evening prior to sleep onset, after awakenings made alternately at the onsets or ends of REM periods, and 15 min after awakening in the morning. Accuracy of binocular depth perception was significantly better at the ends of REM periods than at their onsets ($p < .001$), whereas accuracy of monocular depth perception did not significantly differ. That the monocular task was sensitive to variables of sleep was indicated by impairment at the first REM onset with little variation throughout the night, so that it was significantly worse 15 min after morning awakening than the previous evening ($p < .05$). In contrast, accuracy of binocular depth perception was significantly better in the morning than the previous evening and at REM onsets ($p < .05$).

- 72 Bergstrom, B., & Arnberg, P. Heart rate and performance in manual missile guidance. Perceptual & Motor Skills, 1971, 32, 352-354.

Earlier stress studies under laboratory conditions show that heart rates from 100-110 bpm are associated with significant decrements in missile-tracking performance. Data from real missile tracking by 8 operators with no stress deliberately induced indicate, however, that performance is unaffected up to 135 bpm, and only moderately affected in the 135-170 bpm region. The disagreement between the 2 sets of results highlights the difficulties in generalizing from stress experiments.

- 73 Bergum, B. O. A taxonomic analysis of continuous performance. Perceptual and Motor Skills, 1966, 23, 47-54.

A conceptual framework is presented, based upon an expanded concept of activation level, which is designed to encompass the full range of performance task research, from vigilance to production-line type performance. Specific characteristic aberrations in performance are associated with specific extreme deviations in activation level and a matrix of task characteristics is developed for relating tasks in terms of their total stimulation value and for predicting the effects of experimental variables on the performance associated with these tasks.

- 74 Bergum, B. O., & Lehr, D. J. Affect level, capillary pulse pressure, and response latency. Journal of Applied Psychology, 1967, 51, 316-319.

Examined the effects of the interest value of stimuli on pulse rate, capillary pulse pressure, and overt evaluation response latencies. Twelve Ss evaluated 20 4-letter words in terms of an interesting-dull dimension under both visual and auditory presentation conditions while the 3 measures of interest were simultaneously and continuously recorded. The results indicate no relationship between pulse rate and interest level, but significant functional relationships between both capillary pulse pressure and overt response latencies and levels of interest.

- 75 Berkhout, J. Simulated time-zone shifts and performance ability: Behavioral, electroencephalographic and endocrine effects of transient alterations in environmental phase. In A. J. Benson (Ed.), Rest and activity cycles for the maintenance of efficiency of personnel concerned with military flight operations. AGARD Conference Proceedings, No. 74, 1970. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365; Attn: Report Distribution and Storage Unit)

Three subjects were maintained on an experimental sleep-activity time-line which simulated a flight assignment crossing ten time-zones eastbound and return within 72 hours. The subjects were required to operate an automobile and an array of electronic equipment during the simulated flights. Sleep periods were assigned during the simulated local night, involving a ten hour translation of normal habits, and occasioning two 12 hour epochs of sleep deprivation. Including baseline and recovery periods, the subjects were studied continuously for nine days.

Mental calculating ability, motor coordination and auditory perceptual acuity were determined several times per day throughout this period. Electroencephalograms were recorded during all assigned sleep periods and during the administration of behavioral tests. All urine produced during the experiment was collected, and volume, osmolality, creatinine and 17-OHC levels were determined as a function of time-of-day.

The EEG recordings provided useful monitoring of the subjects' transient arousal status, and permitted the resolution of observed behavioral deficits into sleep-induced, stress-induced and idiopathic classes. The urine chemistry determinations provided measures of circadian physiological fluctuations and their distortion following sleep-activity dislocations, and provided independent estimates of endocrine stress and energy expenditure.

Behavioral capability was observed to depend on several factors, including baseline circadian phase, time-since-waking (an approximation of local circadian phase), endocrine stress and subjective fatigue.

Conclusions will be drawn concerning the optimum scheduling of crew assignments on extensive trans-meridian flights.

- 76 Berkhout, J., & Walter, D. O. Temporal stability and individual differences in the human EEG: An analysis of variance of spectral values. IEEE Transactions on Bio-Medical Engineering, 1968, 15, 165-168.

Normalized power spectra were determined for each of a series of 30 five- and ten-second epochs of eight-channel EEG recordings, taken from 47 subjects under conditions of rest and perceptual task stress.

The data thus obtained were evaluated by an analysis of variance to determine their dispersion characteristics.

In the eyes closed resting case, all channels and frequencies demonstrated statistically significant spectral differences between individuals, when compared to the dispersion of values within individuals. The temporal stability of the EEG was itself a significant factor in discriminating individuals. During performance of a visual task, spectral individuality was greatly decreased in the frontal-temporal region, while maintained in the parieto-occipital area. Distinctive behavior of certain specific frequencies was noted.

- 77 Berlyne, D. E. Conflict and the orientation reaction. Journal of Experimental Psychology, 1961, 62, 476-483.

Three experiments were carried out with the dual aim of studying the influence of collative stimulus properties on the amplitude of the orientation reaction and testing the hypothesis that conflict underlies the motivational effects of collative variables. The GSR was used as an index of the orientation reaction.

In Exp. I, using forced-choice and free-choice reactions, GSR amplitude increased with degree of conflict, unconfounded with novelty, surprisingness, intensity, and distance from fixation point, of stimuli. A preliminary phase with no overt responses showed that the effect was not due to inherent properties of the stimulus patterns, e.g., differences in complexity. In Exp. II, using word association, GSR amplitude increased with response uncertainty, regarded as a measure of degree of conflict. In Exp. III, stimuli that were surprising without being novel, surprise being interpreted as a form of conflict, likewise produced more intense GSRs than others.

- 78 Berlyne, D. E. The development of the concept of attention in psychology. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology, London: Butterworths, 1969.

So while it is gratifying that problems covered by the word 'attention' are coming in for more scrutiny on the part of both neurophysiologists and psychologists, the word can be rather treacherous. To decide exactly what questions are answered by experiments that purport to deal with attention requires a great deal of circumspection—more than it usually receives. Collaboration between the two disciplines may well be of value. Hitherto, there has been a tendency for neurophysiologists to assume that the psychologists know what attention is and for psychologists in turn to assume that the neurophysiologists know!

Both neurophysiological and psychological experiments commonly expose a subject to conditions in which anybody using ordinary language would say that he must be 'paying attention' to a particular stimulus. The stimulus in question may be one that calls for some verbal or manual response, or it may frequently herald some stimulus that calls for an overt response. Alternatively, the stimulus in question may be one with important biological or 'emotional' associations. The effects of these conditions on, say, electrocortical phenomena or learning are then noted. The conditions are assumed to be representative of a large set of conditions conducive to 'attention'. However, the precise membership of this set and what exactly its members are supposed to have in common are rarely, if ever, made clear.

- 79 Berlyne, D. E., & Borsa, D. M. Uncertainty and the orientation reaction. Perception & Psychophysics, 1968, 3, 77-79.

In Experiment 1, blurred pictures evoked longer desynchronization than clear pictures but not more intense GSRs. Experiment 2 confirmed that the EEG effect depended on subjective uncertainty by showing that it did not occur when a blurred picture was immediately preceded by a clear version of the same picture.

- 80 Berlyne, D. E., Craw, M. A., Salapatek, P. H., & Lewis, J. L. Novelty, complexity, incongruity, extrinsic motivation, and the GSR. Journal of Experimental Psychology, 1963, 66, 560-567.

Skin resistance was recorded from human Ss, while each item of a sequence of visual patterns received 3 successive 3-sec exposures at 12-sec intervals. The patterns comprised "less irregular" and "more irregular" items, representing a number of "complexity" and "incongruity" variables. Extrinsically-motivated Ss, i.e., those who were told to attend carefully because they would later undergo a recognition test, produced more frequent GSRs than Ss without such extrinsic motivation. There was a decline in GSR frequency after the 1st exposure of a pattern but a revival when the next pattern appeared. There was also a long-term decline over patterns. Incongruous pictures evoked GSRs of greater mean amplitude than nonincongruous pictures. Some support was obtained for the conclusion that "more irregular" patterns are more likely to evoke GSRs than "less irregular" patterns.

- 81 Berlyne, D. F., & Lawrence, G. H., II. Effects of complexity and incongruity variables on GSR, investigatory behavior, and verbally expressed preference. Journal of General Psychology, 1964, 71, 21-45.

In two experiments, visual figures were given 0.2-second exposures, and GSRs were recorded. The aim was to study the effects of a number of variables that may collectively be placed under the headings of "complexity" and "incongruity" on the orientation reaction. Neither the first experiment, measuring skin potential, nor the second experiment, measuring skin resistance, showed any of these variables to have a significant effect on the magnitude of the GSR. The second experiment also tested the effects of some of the same variables on the rate at which the GSR declines with repeated presentation of a figure. There was such a decline, but its rate was not significantly influenced by any of the variables.

Later phases of the same experiments, in which Ss could look at the figures for as long as they wished, showed exploration of more irregular (i.e., more "complex" or "incongruous") figures to be significantly longer with all five variables studied with low-complexity material and with one of three variables studied with high-complexity material. This confirmed an effect that previous experiments, using different techniques, had demonstrated with the low-complexity material, but that had not previously been tested with the high-complexity material.

The second experiment also incorporated a phase in which Ss had to rank-order the figures according to their degree of liking for them. Verbally expressed preference was not positively related to exploration time and, in contrast, there was a tendency, as far as some of the variables and the material as a whole are concerned, for less irregular figures to be preferred.

Finally, the second experiment showed figures previously seen in the GSR Phase to attract less prolonged exploration but a higher mean ranking in the Preference Test than figures not previously seen. A third experiment suggested that the effect on preference was due to familiarity rather than to the reduction of perceptual curiosity.

- 82 Berlyne, D. E., & McDonnell, P. Effects of stimulus complexity and incongruity on duration of EEG desynchronization. Electroencephalography and Clinical Neurophysiology, 1965, 18, 156-161.

1. Human subjects were exposed to a sequence of visual patterns, each shown twice consecutively. Exposures lasted 3 sec and were separated by intervals of 15 sec. The patterns belonged to eight categories, representing various complexity and incongruity variables.

2. More complex or incongruous patterns evoked, on the average, longer desynchronization than less complex or incongruous patterns. (6.3 sec as compared with 5.8 sec). The difference was found to be statistically significant when the data for all eight categories were examined together and when the data for four of the categories (representing Irregularity of Arrangement, Amount of Material, Incongruity and Random Redistribution) were examined separately.

3. No significant difference appeared between first and second presentations of the same patterns or between subjects who were extrinsically motivated (told to attend carefully for the sake of a later recognition test) and not extrinsically motivated, and none of the interactions was significant. There was, however, a significant tendency for desynchronization to grow shorter as the session continued.

4. The findings are discussed in relation to theoretical and experimental work on motivational aspects of exploratory behavior and related phenomena.

- 83 Bernstein, A. S., Taylor, K. W., & Weinstein, E. The phasic electrodermal response as a differential complex reflecting stimulus significance. Psychophysiology, 1975, 12, 158-169.

To examine the influence of stimulus significance on the skin conductance response (SCR), a 21-sec, 1,000-Hz tone was sounded variously in one ear or the other of 64 male undergraduates. A click occurred during many tones, and a light signal always followed offset by 9 sec. Four groups were studied: one was told to press a pedal immediately on hearing any click; another only on hearing the click during a tone in a specified ear; a 3rd was also to respond only to the specified ear, but was to withhold the press until the light following tone-offset; and a 4th group simply listened without any response. Each of a series of predictions regarding the incremental effect of stimulus significance on the SCR was confirmed, at each point at which information was delivered on any trial (i.e., tone-onset, click, tone-offset, or light-onset). This was true for both independent as well as for within-S (between ear) comparisons. The presence of verbally induced "significance" as well as the complex nature of its influence indicated the presence of central mediation in the elicitation of "peripheral" SCRs. An execute-SCR was identified which correlated uniquely with motor reaction time, did not habituate, and did not correlate with SCRs elicited by other signals in this task. The execute-SCR did not simply reflect judgments of "significance"; rather, it was qualitatively distinguished from other SCRs which, in general, were associated with stimulus "significance."

- 84 Berry, R. N. Changes in finger volume during a simple addition task. Psychological Reports, 1960, 7, 446.

The finger volume data were analyzed for each S by assigning a zero value to a point in the initial 2-min "rest interval" preceding the first problem. The point was 30 sec from the beginning of the rest interval. All other values were converted to percentages of volume change from this point. The values of most interest are the midpoints of the 10-sec work intervals. The median values for each serial position were determined for the three different orders of presentation and showed a significant decrement in volume from beginning to end of task for all three orders of presentation. Next, a single measure of finger volume change was determined for each S by counting the total number of problems on which the finger volume showed a decrease, from rest level, of 1% or more. These scores were then correlated with numbers of correct answers obtained by each S. The resulting rank-order correlation was .51 ($p < .01$). It is concluded that the degree of vasoconstriction in the finger is positively and significantly correlated with the quality of performance in a simple verbal task.

- 85 Besrest, A., & Requin, J. Development of expectancy wave and time course of preparatory set in a simple reaction-time task: Preliminary results. In S. Kornblum (Ed.), Attention and performance IV. New York & London: Academic Press, 1973.

The cortical expectancy wave (EW) of 12 human subjects was analyzed in a variable interstimulus-interval (ISI), simple reaction-time (RT) task. The experimental design involved four conditions that differed in the subjective conditional probability (CP) distributions of the executive signal, considered as the major determinant of preparation time course. Changes in subjective CP were obtained either by varying the frequency distribution of ISIs or by introducing a time mark in the RT context. While the RT-ISI length relationship differs only slightly between experimental conditions, EW development appears strictly related to the hypothesized preparatory process timing.

- 86 Beyn, E. S., Zhirmunskaya, E. A., & Volkov, V. N. Electroencephalographic investigations in the process of recognizing images of objects during their tachistoscopic presentation -- I. Investigations carried out on normal subjects. Neuropsychologia, 1967, 5, 203-217.

The authors carried out a complex electrophysiological and psychological investigation of a group of normal subjects (thirteen persons) in which the method of recording the cerebral bioelectrical activity constituted a component part of psychological experiments connected with the recognition of tachistoscopically presented pictures of objects. The investigation corroborates the modern concepts of the active nature of perception; it helps to reveal some of the mechanisms which are responsible for the formation of visual images and to objectivize the neurodynamic processes connected with the perception and recognition of images.

- 87 Bickford, R. G., Jacobson, J. L., & Cody, T. R. Nature of average evoked potentials to sound and other stimuli in man. Annals of the New York Academy of Sciences, 1964, 112, 204-224.

1. A human "sonomotor" response system has been described in which click stimuli produce widespread activation of the muscular system with latencies ranging from 6 msec (inion, cervical) to 50 msec (leg).

2. These responses can be detected throughout the cranial musculature and are believed to be the basis of the so-called cortical responses to auditory stimulation reported by Geisler, Frishkopf, and Rosenblith.

3. Studies using patients with various lesions of the audiovestibular system have indicated that the receptors in the "sonomotor" response are vestibular rather than cochlear. Hence, the test cannot be used as a valid measure of hearing function.

4. A varying degree of myogenic contamination can be shown to accompany the average responses to other sensory inputs (light, somesthetic) and suggest the need for caution in the interpretation of average responses derived from the human scalp.

- 88 Bills, A. Studying motor functions and efficiency. In T. G. Andrews (Ed.), Methods of psychology. New York: John Wiley and Sons, Inc., 1948.

The experimental study of efficiency in performance can be approached from two different angles, the analytical and the integrative. The first approach leads to experiments of the type exemplified by the quantitative study of the knee jerk, the simple, choice, and serial voluntary reactions, facilitative and inhibitive sets, and the ergographic record of isolated muscle groups. The second approach is concerned with the work of the integrated organism. It is mainly occupied with the effect of continuous performance on efficiency in the performance being studied and in related activities. These effects are studied at three levels: the objective output, the organic energy expenditure, and the subjective feeling-tone, and are expressed graphically in the curve of work. Recuperation from these effects is studied through the curve of recovery. Finally, the study of the influence of factors extraneous to the task itself, whether physiological or within the environmental setting, requires the use of special methods to overcome suggestion and the subtle motivational influences to which the human reactor is peculiarly susceptible.

- 89 Birren, J. E. Age changes in speed of behavior: Its central nature and physiological correlates. In A. T. Welford & J. E. Birren, (Eds.), Behavior, aging, and the nervous system. Springfield, IL: Thomas, 1965.

The data for the young men showed a significant difference between the P phase and the QRS interval; the former showing faster reaction times. In contrast the older men showed slower reaction times than the young men but they did not vary significantly with the cardiac cycle.

No correlation was found between either mean alpha frequency or mean voltage and mean reaction time in the young subjects. Furthermore, when the reaction times of each subject were divided into two groups according to whether the signal occurred at alpha frequencies greater or lesser than the mean for the individual or at voltages greater or lesser than the mean of the individual, no significant difference was found. In young male subjects therefore, no relationship was found between response speed and alpha frequency or voltage either within or between subjects.

Differences in mean response times were found between response to signals in alpha or no alpha phases.

- 90 Birren, J. E., Cardon, P. V., Jr., & Phillips, S. L. Reaction time as a function of the cardiac cycle in young adults. Science, 1963, 140, 195-196.

Simple reaction times to auditory stimuli varied with the phase of the cardiac cycle in which the stimuli were presented, tending to be fastest to stimuli presented during the F-phase of the electrocardiogram. One hundred reaction times obtained from each of 56 men and women between the ages of 20 and 30 years were analyzed.

- 91 Bittker, T. E., Buchsbaum, M. S., Williams, R. B., Jr., & Wynne, L. C. Cardiovascular and neurophysiologic correlates of sensory intake and rejection. II. Interview behavior. Psychophysiology, 1975, 12, 434-438.

As part of a three task study of the influence of attentional style on cardiovascular response, 19 normal volunteers were given a 15-min interview during which systolic and diastolic blood pressure, digital pulse volume, heart rate, and forearm blood flow were recorded. At the same time two observers independently assessed five elements of the subjects' interview behavior; arousal, eye contact with the interviewer, self-revelation of interview center, attentiveness to the interviewer, and overall transactional engagement in the interview task. When subjects were divided into groups of interview attenders and nonattenders on the basis of interviewer ratings, attenders had a mean decrease in forearm blood flow and nonattenders a mean increase. These group differences extended across a word identification (sensory intake) and mental arithmetic (sensory rejection) task as well. When subjects were divided into groups of forearm blood flow increasers and decreasers, increasers displayed less attentiveness to the interviewer, less self-revelation, greater arousal, and less transactional engagement than did decreasers (N=9). Attentiveness to the interviewer and transactional engagement were the two most sensitive behavioral discriminators in comparing the increaser and decreaser groups.

- 82 Bjerner, B. O. Alpha depression and lowered pulse rate during delayed actions in a serial reaction test. Acta Physiologica Scandinavica, 1949, 19, Supplementum No. 65, 1-93.

The delayed actions were associated with a transient fall in pulse rate (chapter 6). Dividing the delayed actions according to length into groups of under 1.5 seconds, 1-2, 2-3, 4-5 and over 5 seconds, showed that the difference from both the preceding and succeeding pulse rate was statistically significant at either the one percent or one per mille significance level in all except the first group.

The longer the delayed action, the greater was the accompanying difference in pulse rate. The delayed actions occurring during the first three minutes of the experiments were not accompanied by a demonstrable difference in pulse rate. The same was true of the ones occurring in the experiments carried out at 10 p. m. The difference was pronounced in the delayed actions occurring in the 4 to 10 a. m. experiments.

The delayed actions were also accompanied by depression of the alpha activity (chapter 7). As in the case of the pulse rate, the decrease in the number of alpha waves both in relation to the preceding and succeeding number was significant at the one percent or one mille significance level for all the length groups of delayed actions except those lasting less than 1.5 seconds.

Study of the delayed actions lasting longer than five seconds showed that they contained all the stages between wakefulness and overt sleep, the presence of the latter being diagnosed by direct observation of the subject and electroencephalographic criteria, viz. disappearance of alpha activity, appearance of delta activity, spindles and K-complexes. It was concluded from this that delayed actions are transient phenomena of the same nature as sleep.

- 83 Black, S., & Walter, W. G. Effects on anterior brain responses of variation in the probability of association between stimuli. Journal of Psychosomatic Research, 1965, 9, 33-43.

The effects of variation in the probability of association between sensory stimuli were studied by electroencephalography in man. Variations in the probability of association were induced by direct suggestion under hypnosis of hallucinated, additional and unassociated stimuli, as well as by the presentation of varying proportions of real, additional and unassociated stimuli. Polygraphic records with electronic averages of non-specific cortical responses to stimuli in the sensory modalities of hearing, vision and touch were taken from 5 deep-trance hypnotic subjects in 20 experiments and from 90 other subjects in the waking state. The experiments were based on the interaction between two associated stimuli of different modalities, which results when the first stimulus is irregularly presented and is followed regularly in time by the second stimulus. In these circumstances the negative component of the non-specific cortical response to the second stimulus is reduced and contingent habituation occurs.

Working with auditory and visual stimuli in particular, it was found that when the probability of association between clicks and flashes presented in this way was diluted with frequent hallucinated, additional and unassociated clicks produced by direct suggestion under hypnosis, the interaction between the two stimuli was modified and the negative component of the response to the second stimulus, or flash, reappeared. This negative component of the response to the second stimulus was also found to return when the probability of association between the two stimuli was diluted with real, additional and unassociated clicks.

It is concluded that the responses of non-specific anterior cortex to associated sensory stimuli are a function of the probability of association between the stimuli.

- 94 Blake, M. J. F. Physiological and temperamental correlates of performance at different times of day. Ergonomics, 1965, 8, 375-376. (Abstract)

This paper reports the results of an experiment to investigate the effects of time of day on performance at a 30-minute letter-checking task. Twenty-five subjects were tested at five times of day in a balanced Latin Square design. Test times were 0800, 1030, 1300, 1530, and 2100. Each test was carried out in an enclosed booth, and the subject was given no knowledge of results. Body temperature (oral clinical thermometers) and radial pulse measures were taken before and after every test for each subject. Scores on the Heron Personality Inventory (Heron 1956) were obtained from all subjects.

Group mean performance varied roughly as the mean body temperature at the different times of day, being lowest at 0800 and highest at 2100. In addition a positive correlation across subjects between performance and body temperature was observed at each time of day. This changed through the day, being highest in the morning and diminishing towards the evening. There was also a statistically significant ($p < 0.05$) reversal of correlation between performance and Heron Part II score, the introverts checking more letters at 0800 and the extraverts more at 2100.

- 95 Blake, M. J. F. Relationship between circadian rhythm of body temperature and introversion-extraversion. Nature, 1967, 215, 896-897.

Although relatively small, this relationship between personality, body temperature and time of day may help to explain the performance differences in introverts and extraverts referred to previously, if it is assumed that temperature reflects the level of "arousal" of the nervous system, and that performance efficiency is related to this level. Comparative measurements with a variety of different groups would be necessary to determine whether the relationship (and also the form of the body temperature curve observed) is characteristic of the particular type of subject used, or whether it is typical of the population at large.

- 96 Blake, M. J. F. Time of day effects on performance in a range of tasks. Psychonomic Science, 1967, 9, 349-350.

Performance on eight tasks ranging from novel laboratory tests to highly practised familiar skills was measured at five times of day between 8 AM and 9 PM. Five tasks showed a consistent tendency for improvement in efficiency from 8 AM through 9 PM: in one task there was deterioration; and in the remaining two the effects were not significant. The results suggest that the observed trends are related to the underlying state of arousal as indicated by body temperature.

- 97 Blake, M. J. F. Temperament and time of day. In W. P. Colquhoun (Ed.), Biological rhythms and human performance. London and New York: Academic Press, 1971.

The evidence presented in the previous chapter demonstrated that, in many conditions, performance at certain kinds of task exhibits a quite marked circadian periodicity, which appears, in general, to be in phase with the concurrent rhythm of body-temperature. The present chapter describes in some detail the results of one particular series of experiments in which the relationship between variations in temperature and performance during the waking day was studied over a wide range of "mental" tasks; and attempts to relate the individual differences observed to an objective measure of a particular personality characteristic, namely, introversion-extraversion. This series of experiments was referred to in the "waking day" section of the previous chapter.

As already noted, a common shortcoming of the majority of studies on time of day effects on performance has been the relatively small number of subjects observed in any single investigation. In "long-term" experiments such as the shift-work and watch-keeping projects described in the last chapter this defect is understandable, since the magnitude of the undertaking almost invariably precludes the use of a larger number of individuals. The same restriction does not necessarily apply to "short-term" experiments, however, and one of the aims of the investigation to be described here was to ensure that the number of individuals tested in each case was sufficiently large to enable relatively firm conclusions to be drawn about any effects observed. It is obvious also that the second aim of the present study, the analysis of individual differences, would in any case hardly be practicable with very small groups.

- 98 Blake, M. J. F., & Corcoran, D. W. J. Introversion-extraversion and circadian rhythms. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

We are, therefore, at a disturbing though interesting phase in the understanding of the mechanism which differentiates introverts and extraverts. Almost all existing work on the topic suggests that some general difference exists in the arousal mechanism; most of it indicates that introverts are higher in arousal than extraverts whatever the time of day at which readings are taken, yet the work summarised here suggests that circadian rhythms are certainly involved.

- 99 Blaylock, B. A. H. Some antecedents of directional fractionation (Doctoral dissertation, University of Illinois at Urbana-Champaign, 1970). Dissertation Abstracts International, 1971, 31, 5653R. (University Microfilms No. 71-5049)

Three stimulus variables appear especially relevant to a more complete understanding of directional fractionation: 1. Type of task ("intake" vs. "mental work"). 2. Verbalization instructions (whether S was told he would have to answer questions later or not). 3. Stressfulness of the test (threat of shock punishment vs. no threat). The effects of the above-mentioned variables on HR and SC change were therefore investigated. Ss were 89 male students from an introductory psychology class at the University of Illinois.

The results of the present experiment support Lacey's "intake-rejection" theory, fail to confirm Campos and Johnson's findings that later-verbalization instructions are associated with HR acceleration, contradict the arousal theory assumption that autonomic responses to a stimulus always change in the sympathetic-like direction, provide support for Lacey's notion that HR behaves like the algebraic sum of two or more opposing forces, and suggest the need for further exploration of the combined effects of the "arousal" and "intake-rejection" dimensions. Furthermore, the findings are consistent with Graham and Clifton's assertion that HR deceleration is a component of the "orienting reflex" to novel stimuli.

- 100 Blaylock, B. Some antecedents of directional fractionation: Effects of "intake-rejection," verbalization requirements, and threat of shock on heart rate and skin conductance. Psychophysiology, 1972, 9, 40-52.

Following recent contradictory claims in the literature regarding the phenomenon of directional fractionation, the present study was designed to investigate variables related to this differential patterning of autonomic response. Heart rate (HR) and skin conductance (SC) were recorded from 89 male students who either attended to flashing lights or worked a subtraction problem under threat-of-shock or no-shock conditions. Effects of instructions to verbalize later were also investigated.

While significant task differences were demonstrated which were consistent with the directional fractionation hypothesis, instructions to verbalize later affected neither HR nor SC. Threat of shock significantly elevated HR during the task only for Ss attending to flashing lights. However, threat of shock significantly raised HR and SC levels immediately after instructions (and preceding the task) when combined with instructions for subtraction. Results were contrary to arousal theory, supportive of Lacey's theory of an "intake-rejection" dimension, and contrary to Campos and Johnson's verbalization findings.

- 101 Blitz, P. S., Hoogstraten, J., & Mulder, G. Mental load, heart rate and heart rate variability. Psychologische Forschung, 1970, 33, 277-288.

Several investigators have shown that diminished sinus arrhythmia can be seen as an indication of increased mental load. The present experiment deals with the influence of different levels of mental load, operationalized as the number of binary choices per minute, on the regularity of the heart rate. Also we investigated the influence of four different rest conditions on the regularity of the heart rate.

The results show that sinus arrhythmia scores differentiate significantly between several levels of mental load, but heart frequency appeared to be an even better indicator.

No significant differences were found between the four rest conditions. Stability over three subsequent measurement sessions was satisfactory, and reliability within the measurement periods was very high.

- 102 Blix, A. S., Stromme, S. B., & Ursin, H. Additional heart rate — an indicator of psychological activation. Aerospace Medicine, 1974, 45, 1219-1222.

Heart rate and oxygen consumption of helicopter and transport aircraft pilots were measured. During flight operations, the heart rate accelerated without a corresponding increase in oxygen consumption. This heart rate increase beyond that expected from the oxygen uptake, i.e. additional heart rate, is therefore used as an indicator of psychological activation. This activation did not depend only on the actual task, but also on the experience level of the pilot himself. The levels of heart rate (and blood pressure) recorded indicate that even routine missions may impose a hazard to pilots with unmanifested or latent heart failure. This obviously calls for frequent workload-ECG examinations of flying personnel.

- 103 Bloch, R. M., & Lang, P. J. Long interstimulus interval effects on auditory evoked response amplitudes and variances. Psychophysiology, 1977, 14, 113-114. (Abstract)

The effects of 10, 20, and 35 sec ISIs on vertex auditory evoked response amplitudes and variances, and heart rate were compared using trend analysis of variance. Sixteen male subjects were presented 3 sets of 26 tones separated by 3-min. breaks. Within each set tones of 3 different frequencies were presented, randomly separated by the 3 ISIs. Averaged evoked responses (AERs) were obtained for each ISI and stimulus set. To reduce the number of points submitted to trend analysis, each AER was collapsed into 10 points, each one an average of 48 msec. Results indicated that the simplified quadratic and cubic-shaped AER increased linearly in amplitude with increases in ISI. This suggests a long-term process requiring more than 20 sec for completion. Ritter, Vaughn, and Costa (1968) found habituation effects on amplitude absent at intervals of 10 sec thus suggesting the ISI effect is not mediated by diminishing habituation. The fact that ISIs were randomized also argues against an habituation process and for a slow recovery process. Across stimulus sets the AER linearly decreased in amplitude.

Variances for each point in the AER were collapsed and analyzed in the same manner as the means. Interestingly, AER variance had an inverted-V shape, with low variance associated with the initial and late negative components, while the intervening positive component (P200-300) was associated with peak variance. Both stimulus set and interstimulus interval significantly affected AER variance. The positive component variance was greater in the first set and with the longest ISI.

Heart rate showed a complex combination of ISI, rebound, and LIV effects. The initial decelerative component of the triphasic response decreased with increases in ISI, while the following acceleration increased with ISI.

The results of this study suggest the presence of a very slow recovery-type process which reduces AER amplitudes and positive component variances at ISIs of less than 35 sec. Further, this study suggests the promising use of trend analysis of variance to more objectively assess changes in AER amplitude and variance wave-shape. And finally, AER variance demonstrated the selective effects of the ISI and stimulus set manipulations on the positive AER component and deserves more attention in the AER literature.

- 104 Block, J. D., & Resler, M. F. Discrimination and recognition of weak stimuli. Archives of General Psychiatry, 1962, 6, 25-36.

In a group of 15 subjects who demonstrated significant physiological discrimination between presentations of 2 clearly visible stimuli, it was found that this relationship is not a simple one. Physiological discrimination does continue below a simple threshold of chance verbal identification, and in the absence of full conscious awareness of the nature of the stimuli. However, at a given illumination level in the threshold region some presentations of a stimulus are apparently better perceived than others. This event is reflected both psychologically in the subjects' selection of higher confidence categories and above chance identifications, and physiologically in a discriminated autonomic response. Furthermore, these 2 reflections of the registration of weak stimuli appear not to be independent, that is, physiological discrimination is not found in the complete absence of any form of psychological discrimination.

The data also indicate the marked effect of the subjects' mistaken verbal identifications upon their autonomic responses. These "response-effects" are related in some way to psychological and physiological discrimination, as they disappear at the same illumination level as do the other phenomena.

- 105 Blowers, G. H., Ongley, G. C., & Shaw, J. C. Implications of cross-modality stimulus permutations for the CNV. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

The Contingent Negative Variation was measured in nine subjects using an i.s.i. of 5 sec. Each subject endured nine conditions. Each condition consisted of varying the modality in which the conditional (S_1) and imperative (S_2) stimuli were given. Signals were averaged in groups of eight. Measures of three characteristics of the averaged wave forms were collected together with reaction times. All data collected was treated by a Latin Square Statistical analysis. No significant differences in wave form characteristics occurred across the nine conditions. Reaction times were significant in two conditions. The psychological implications of these findings are discussed in terms of a selective attention model.

- 106 Boddy, J. The relationship of reaction time to brain wave period: A re-evaluation. Electroencephalography and Clinical Neurophysiology, 1971, 30, 229-235.

In the first experiment a representative mean alpha period (from temporal and occipital derivations) was obtained for each of twelve subjects, using an automated, power spectrum based, period analysis system with which the EEG was sampled for about a minute. A non-significant inter-individual correlation of 0.37 was found between occipital alpha period and visual RT recorded under conditions of high incentive in a subsequent behavioural experiment. The finding was reproduced with an even lower correlation of 0.05 on another group of seventeen subjects.

In the second experiment mean values of the EEG period were determined for twenty subjects from linear measurements on the chart of the 1 sec EEG sample immediately preceding each RT stimulus. The temporal derivation T_3-T_5 was used during auditory RTs and the occipital derivation T_5-O_1 during visual RTs. The inter- and mean intra-individual correlations between EEG period and RT were 0.21 and 0.10, respectively, for auditory RT and 0.26 and 0.10 for visual RT - statistically non-significant in each case. Thus there was a failure to reproduce the finding of Surwillo in both experiments, a discrepancy whose possible sources are discussed.

- 107 Boddy, J. The psychological refractory period and vertex evoked potentials. Quarterly Journal of Experimental Psychology, 1972, 24, 175-192.

The averaged sensory evoked potential (EP) was recorded from the scalp (vertex to mastoid) in a psychological refractory period experiment in which 12 young adults participated. Reaction times (RTs) were measured to either both or only the second of pairs of stimuli, in different trial blocks, with inter-stimulus intervals (ISIs) of 100, 200, 300 and 400 msec occurring in random sequence. EPs were recorded at each ISI. No latency changes could be found in the prominent non-specific components ($P_1-N_1-P_2$) of the EP to stimulus 2 even at ISIs where the RT was substantially delayed. Thus the notions that the RT_2 delay is due to occupation of a single channel central processor by S_1 and that non-specific EP components reflect the time course of information processing in underlying neural tissue, do not lend each other mutual support. Furthermore, as profound amplitude refractoriness in components P_1-N_1 and N_1-P_2 persisted at ISIs where RT was as fast or faster than simple RT, there appears to be a dissociation between "psychological refractoriness" and "physiological refractoriness". The implications of these results are discussed.

- 108 Boddy, J. Evoked potentials in reaction time with a variable foreperiod. Quarterly Journal of Experimental Psychology, 1973, 25, 323-334.

The reaction times (RTs) of 12 subjects were recorded in a design where a visual or auditory warning signal preceded an auditory RT signal by one of four short foreperiods 500, 750, 1000 or 1250 ms long, which occurred in a random sequence. For the 16 trials at each foreperiod, with each modality of warning signal, the average of the 2-sec long EEG samples following the warning signal was computed so that the record showed the scalp recorded (vertex-left mastoid) evoked potentials (EPs) to both warning and RT signals, and also the contingent negative variation or expectancy wave occurring during the foreperiod.

Differences between RTs with different foreperiods were not reflected in negatively correlated differences in the amplitude of the RT signal EPs, taking the major positive going deflection between peaks N_1 and P_2 at mean latencies of 126 and 231 msec after the RT signal. Furthermore RT signal EPs preceded by a warning signal were highly attenuated in amplitude relative to control EPs which were not preceded by a warning signal, whether or not an RT response was required. This was despite the fact that alerted RTs were slightly faster than non-alerted RTs, so that these findings contradict previous findings associating augmented EPs with responding versus not responding and with speeded RTs.

However, it was found that RT signal EP amplitudes were greater with the more effective modality of warning signal than the less effective, which was consistent with previous findings. The divergence from previous findings when comparing EPs preceded by a warning with those having no prior warning is tentatively accounted for in terms of persisting physiological refractoriness following the warning signal EP.

100 Bogacz, J., Vanzulli, A., & Garcia-Austt, E. Evoked responses in man IV. Effects of habituation, distraction and conditioning upon auditory evoked responses. Acta Neurologica Latinoamericana, 1962, 8, 244-252.

1. Ninety-four experiments were carried out in normal adults, both wakeful and asleep, averaging from 20 to 40 scalp auditory evoked responses (AER) with a photo-optico-electronic method. Habituation was obtained by binaural stimulation with monotonously repeated clicks of a constant frequency (1/sec) and intensity. Distraction was provoked by means of visual stimulation with isolated flashes at different click frequencies. Time conditioning was obtained with discontinuous intermittent acoustic stimulation, and sensory conditioning, by superposing visual and acoustic stimulation. The tympanic electrodes and the right electrodes of the 10-20 system, were employed.

2. Intermittent continuous auditory stimulation provoked changes in the background activity. The most conspicuous finding was the induction of sleep, with many spontaneous oscillations of the level. Upon interrupting this stimulation, an arousal reaction or blocking reaction, was observed. This hypnagogic effect was not so evident with discontinuous stimulation.

3. Habituation constantly provoked changes in: (a) amplitude, which showed a progressive reduction in the wakeful subject and during a constant level of the superficial sleep; (b) simplification of AER, which changed from repetitive to single; (c) limitation of AER to the tympanic electrode where it showed a reduction lower than in other areas of the temporal region.

4. Distraction was accompanied by an immediate or delayed reduction in AER amplitude.

5. During silence-train of clicks association (electrocortical time conditioning), there was increase in AER amplitude, unaccompanied by changes in topographic distribution.

6. When a series of flashes was delivered during the period of silence, either after or before the clicks, no significant changes in AER amplitude was elicited.

- 110 Bogacz, J., Vanzulli, A., Handler, P., & Garcia-Austt, E. Evoked responses in man II. Habituation of visual evoked response. Acta Neurologica Latinoamericana, 1960, 6, 353-362.

1. In 92 experiments a study was conducted of visual evoked response changes during habituation to continuous flicker stimulation.

2. Visual evoked response was detected from scalp by an integration method.

3. The main visual evoked response changes were: (a) reduction of amplitude or disappearance of all its components, particularly of the latter; (b) inconstant increase of latency; (c) tendency to confinement to the occipital region.

4. The foregoing changes assume the form of waxing and waning but with a constant tendency toward decline.

5. In multiple occasions there developed an afterdischarge set up by a synchronization of the background rhythm.

6. In natural sleep visual evoked response changes similar to those seen during wakefulness were observed. Hence the habituation process is also expressed during light sleep.

- 111 Bohdanecky, Z. Vyvolane EEG odpovedi u lidi a vigilance. [Evoked EEG responses and vigilance.] Ceskoslovenska Psychologie, 1969, 13, 348-353.

The article reviews the EEG evoked responses in human subjects and the factors which influence the evaluation. The typical components of the evoked response are mentioned and the basic relations among various levels of the attention, stimulus and character of the individual components of the evoked responses are described.

- 112 Boissonneault, D. R., Dorosh, M. E., & Tong, J. E. The effect of induced heart rate change and neuroticism on the resolution of temporally paired flashes. Psychophysiology, 1971, 7, 465-474.

Normal high extraversion male subjects with high scores on a neuroticism scale were compared with similar subjects with low neuroticism scores, as to changes in the discrimination of paired flashes, brought about by activation-induced heart rate increase. A threshold for fusion indicated slightly improved resolution for the low neuroticism group under increased heart rate, but a marked deterioration for the high neuroticism group. Two signal detection analyses indicated that the differential effects could not be attributed to response criteria and one analysis indicated group differences in sensitivity under activation.

- 113 Bollinger, R. R., O'Donnell, R. D., & Hartman, B. O. Physiological costs of extended airborne command and control operations. In A. N. Nicholson (Ed.), Simulation and study of high workload operations. AGARD Conference Proceedings, No. 146, 1974. (Available from: National Aeronautics Space Administration, Langley Field Virginia 23365; Attn: Report Distribution and Storage Unit)

During Exercise Night Star the personnel of the National Emergency Airborne Command Post successfully documented their ability to maintain a continuous airborne alert for an extended period. Biomedical evaluation began with a pre-exercise baseline study and continued through a postexercise observation period. A variety of psychological and physiological parameters were measured in order to determine the degree of stress, fatigue, and change in performance induced by the extended airborne alert. This biomedical evaluation showed that performance was maintained by the mission teams, flight crews, and ground support personnel. When significant fatigue did occur, whether in flight or on the ground, it developed near the beginning of the exercise. The only cases of marked or persistent fatigue were seen in those groups whose day/night, work/rest cycles were shifted and can be attributed in major part to the resulting sleep loss. However, all groups appeared to adapt to their new work schedules as the exercise progressed. Partial physiologic and complete psychologic recovery were evident within the first 36 hours after the exercise.

- 114 Bonsper, D. E. The effect of increased information processing on sinus arrhythmia and heart beat. Monterey, California: Naval Postgraduate School, September 1970. (NTIS No. AD-712784)

This experiment investigated the effect of increased information processing on heart beat and sinus arrhythmia. A measure of sinus arrhythmia was developed which considered the area between the electrocardiogram rate curve and the average heart beat line. Simple linear correlation analyses were performed to determine the relationships between heart beat, sinus arrhythmia and information processing rate. Sinus arrhythmia was decreased as a result of increased information processing while heart beat was not significantly affected.

- 115 Boros, J. Blutdruck bei der motorischen aktivitat. [Blood pressure in motor activity.] Studia Psychologica, 1967, 9, 248-259.

Analyzed results from blood pressure measurements under 3 differentiated variants, designed to follow the elaboration of simple movement habits by means of EMG methods. It was hypothesized and confirmed that under different experimental variables (length and pace of movement, weight of transported objects), corresponding changes may be expected to occur in blood pressure, and that a gradual acquisition of movement habits in groups of Ss will correlate with recorded blood pressure values. It was not confirmed that training would lead to a decrease of the blood pressure values to the resting level recorded following experimental sessions. It was found that increased demands on perception, attention, and visualization are reflected in vegetative changes, in this case, blood pressure changes. Significant correlations were found between a gradually more complicated movement stereotype and the increasing trend of recorded average systolic blood pressure.

- 116 Boros, J. [Electromyographic method used in the study of silent speech in connection with simple mental activities.] (Slovak) Sbornik Praci Filosofickej Fakulty Brnenskej University, 1972, 20, 35-51.

Conducted an experiment with 2 groups of male Ss, 6 experimental Ss (mean age = 10.1) and 6 controls (mean age = 21.3). EMG data showed that recorded amplitudes of electric biopotentials of the tongue during silent speech in connection with the mental processes followed during arithmetical tasks, listening to texts of various contents, and reading of texts in various languages, are not stable increasing or decreasing in size in dependence on various factors. The dynamics of the recorded biopotentials of the tongue is affected by the difficulty or novelty of the mental tasks which Ss had to solve silently, with the aid of inaudible speech. It is further affected by level or degree of mastering the mechanism of those mental processes that occur during solution of the given tasks, and by individual differences among Ss, particularly as regards a certain type of remembering—imagining (while listening to various texts and during reading foreign language texts)—for the S was required to remember what he had heard or read. Several important conclusions for future work connected with the use of this method in other fields of psychological research, are also discussed.

- 117 Bostock, H., & Jarvis, M. J. Changes in the form of the cerebral evoked response related to the speed of simple reaction time. Electroencephalography and Clinical Neurophysiology, 1970, 29, 137-145.

The relationship between simple auditory reaction time (RT) and form of the cerebral evoked potential was studied in an experiment with eighteen normal subjects. Stimuli were presented in a fixed relationship to the subject's cardiac cycle, and the data were analysed separately in terms of (1) phase of cardiac cycle at which the stimulus was presented, (2) speed of RT and (3) time in the experiment.

The amplitude and latency of a wave of around 250 msec latency (N_2) were found to relate very strongly, both within and across subjects, to the speed of RT. Amplitudes of earlier components, while also related to RT, were equally or more associated with time in the experiment. The N_2 component was interpreted as an index of the moment-to-moment level of arousal.

Neither the form of the evoked response nor the speed of RT was related to the phase of the cardiac cycle at which the stimulus was presented.

- 110 Bottge, H. Beitrag zur Theorie und Praxis der Analyse des Spontanen Elektroenzephalogramms. [Theory and practice of the analysis of spontaneous electroencephalograms.] Doctoral dissertation, Technische Universitaet Muenchen, 1972.

A comparison of the various trial solutions for analyzing the central nervous activity from neurophysiology, communications theory and control theory and other scientific areas, leads to the realization, that for ergonomic analysis, the various models of the sequence of mental processes are still very incomplete.

The problem of analyzing the electroencephalogram is discussed and known analysis methods are compared. After developing 10 criteria for a high performance analysis technique which satisfies practical requirements, these criteria are compared with known methods. The degree of satisfaction of the 10 criteria are discussed and suggestions are given for improving the method. Suggestions are also given for improving the measurement technique and for the method of treating the data, in the case where the analysis methods do not fully satisfy certain criteria. Finally, considering the limited computer capacity and for optimum satisfaction of the 10 criteria, we describe the fundamentals of a recognition system for spectral patterns in the signal of the EEG, and its technical and organizational structure.

The results of the first test measurements, discussed at the conclusion of the paper, as well as the detection of stimulus-non-specific parameters in the spontaneous activity of the EEG for describing certain degrees of wakefulness when using the recognition system in wakefulness research show that the system can satisfy the 10 criteria of a high performance analysis technique with a limited computer capacity. Therefore, new foundations have been produced for answering a large number of ergonomic questions, especially for mental stress.

- 110 Bottge, H., & Holoch, J. Ein Erkennungssystem für spektrale Muster in spontanen Elektroenzephalogramm und seine Anwendung in der Wachsamkeitsforschung. [An identification system of spectral patterns in a spontaneous electroencephalogram and its application in vigilance research.] Psychologische Beiträge, 1973, 15, 341-374.

Studied changes in the spectral parameters of the spontaneous EEG as indicators of various levels of psychophysical activity at 1 performance. To test their state of vigilance, 4 Ss were exposed to a series of 8 2-hr Mackworth Clock tests consisting of 4 12-signal 30-min test periods following each other without any interruption. Two repeat tests were conducted 6 mon later. Four states of vigilance were defined and measured: nondirected vigilance (open eyes, no task); directed vigilance (closed eyes, expecting signal, reaction to signal); reduced vigilance (eyes open, expecting signal, no reaction to signal) and vigilance with incorrect reaction (eyes open, reaction without any signal). The identification system for spectral patterns is explained and the 10 criteria developed for a flexible technique of analysis are discussed in detail. It is stated that the analysis of the 1st test measurements and the evidence of stimulus-nonspecific parameters in the spontaneous EEG activity describing the various states of vigilance indicate that the outlined system is workable and should be studied more extensively.

- 120 Botwinick, J. Theories of antecedent conditions of speed of response. In A. T. Welford & J. E. Birren (Eds.), Behavior, aging and the nervous system. Springfield, IL: Thomas, 1965.

Biopotential wave theory, the third theory that was discussed, may not really be conceptually different from set theory, but it is distinguishable by the fact that experimental measurements include physiological recordings, principally the EEG, and that a particular c.n.s. mechanism is thought to underlie arousal, alertness, set, etc. Alpha blockade, in response to sensory stimulation, is believed to be a reflection of alerted states of the organism due to activation of the ascending projections of the reticular formation of the brain stem. By hypothesis, alerted states of the organism are expected to be related to fast RT, and non-alerted states to slow RT. The data are, in general, supporting of the hypothesis, but also mitigating of it. Alpha is blocked experimentally by providing the subject with a warning signal of the PI. Percent alpha is related to duration of PI. Thus, when RT is found to be a function of per cent alpha blockade, it is confounded with PI. That is, the operation of PI variation both leads to alpha blockade and to RT reduction. Investigators have concluded that both these aspects are related to a common mechanism. This may be, but it may also be that they are independent aspects of the organism, each related to PI, but not correlated to reticular formation activation, or any other mechanism. Supporting this conclusion are the data of RT measurements with spontaneous alpha blocking. Here, RT is not at all related to the state of alpha.

The common mechanism hypothesis does receive support from those studies that successfully indicate relation between RT and phases of the alpha cycle. The relationship as reported, however, appears variable, and not necessarily of great extent. This would suggest that even if a common alerting mechanism were involved, other mechanisms, common or otherwise, play an important role in RT.

- 121 Bowers, K. S. Heart rate and GSR concomitants of vigilance and arousal. Canadian Journal of Psychology, 1971, 25, 175-184.

Ss receiving high shock during this experiment were considerably more autonomically aroused than low shock Ss, as indicated both by an index of GSR, and by heart rate corrected for base level. When corrected, vis a vis a running baseline secured throughout the course of the experiment, heart rate did not differentiate between Ss receiving high and low level shock. In a within Ss comparison, however, UCS temporal uncertainty generated lower corrected heart rate than UCS-certainty, and did so independently of shock level. It is unlikely that UCS-uncertainty was less anxiety arousing than UCS-certainty; indeed, GSR data suggest the contrary was true. The decrease in heart rate during UCS-uncertain trials is presumed to be a function of Ss' increased vigilance for uncertainty removing cues. The cognitive orientation toward environmental intake which such vigilance implies should, according to Lacey (1967) be accompanied by cardiac deceleration. It was argued that such cognitive aspects of cardiac functioning are superimposed over gross cardiac responsiveness to autonomic arousal.

- 122 Boyce, P. R. Sinus arrhythmia as a measure of mental load. Ergonomics, 1974, 17, 177-183.

Conducted an experiment with 10 male graduate researchers involving a subtraction task in which the physical and mental loads could be varied independently. Results indicate that sinus arrhythmia decreased with an increase in mental load. However, heart rate could also be used to differentiate between the mental loads. In addition it was found that both heart rate and sinus arrhythmia increased for an increase in physical load. This increase in sinus arrhythmia can be explained by the static work component of the physical load and of the scoring system used. It is concluded that changes in heart rate and sinus arrhythmia are best regarded as generalized responses to the imposition of a load.

- 123 Bradley, S., Hack, K., & Newton, M. A study of electrophysiological measures of stress related to some operationally defined tasks. (AP Report No. 7). Birmingham, England: University of Aston, Applied Psychology Centre, September 1966.

The experiment was designed to investigate whether a relationship exists between degree of physiological arousal and the performance of a series of operationally defined tasks, graded in difficulty by standardization against the G.S.R. Differences in arousal will also be related to measures of personality and general intellectual ability.

- 124 Bradshaw, J. L. Load and pupillary changes in continuous processing tasks. British Journal of Psychology, 1968, 59, 265-271.

Examined the interaction of rate of presentation, and number of transforms and possible responses in connection with the effect of cognitive load upon pupillary dilation. The task involved continuous processing of auditorily presented material. The two criteria of task difficulty both contributed to raising pupillary diameters, which were further increased at the moment of button-press responding. That variations in level arousal were involved was further borne out by the tendency for certain regular changes to occur in pupillary dilation in the course of the processing tasks.

- 125 Bradshaw, J. L. Pupil size and problem solving. Quarterly Journal of Experimental Psychology, 1968, 20, 116-122.

Pupil size changes were monitored during the solution of various types of problems. A number of solution and response strategies were required of the 6 undergraduate Ss. There was strong confirmation of the theory that this autonomic index can provide a sensitive measure of the fluctuating levels of attention and arousal which are associated with the various aspects of information processing and response.

- 126 Bradshaw, J. L. Pupillary changes and reaction time with varied stimulus uncertainty. Psychonomic Science, 1968, 13, 69-70.

In an RT task, an increase in stimulus uncertainty led to increased RT. This was achieved by varying the number of possible sensory modalities for the signal, changing the length or variability of a warning foreperiod, and concurrently presenting masking noise. At the highest levels of uncertainty, concurrently monitored pupillary dilation showed an overall flattening of associated response peaks, together with a rise in base line levels. There was also evidence of expectancy phenomena with nonoccurring, anticipated signals.

- 127 Bremner, F. J., Moritz, F., & Benignus, V. EEG correlates of attention in humans. Neuropsychologia, 1972, 10, 307-312.

Attempted to extend the attention model proposed by F. J. Bremner and his coworkers to EEG data from 20 male undergraduates. Data are presented which show changes predicted by the expectancy subset originally defined by animal EEG data. An additional subset, internal focus, is proposed and partially supported by changes in human EEG. It is suggested that this subset is unique to humans.

- 128 Briction, C. A., McHugh, W., & Naitoh, P. Prediction of pilot performance: Biochemical and sleep-mood correlates under high workload conditions. In A. N. Nicholson (Ed.), Simulation and study of high workload operations. AGARD Conference Proceedings, No. 146, 1974. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365; Attn: Report Distribution and Storage Unit)

A preliminary longitudinal study of the factors affecting the carrier landing performance of naval aviators under high workload conditions has been carried out. Using stepwise multiple regression techniques, a substantial portion of the variability in landing performance could be accounted for by six factors under zero cumulative workload conditions and by seven factors under moderate cumulative workload conditions. High cumulative workload conditions sharply reduced predictive ability. Although specific aircraft experience and total flight experience were important predictors of average landing performance, blood biochemical levels and emotional states had significant predictive ability. Sleep patterns relate strongly to performance. The factors that determine landing performance change as cumulative workload increases. Suggestions for further research in this area are discussed.

- 129 Brown, B. B., & Klug, J. W. (Eds.), The alpha syllabus: A handbook of human EEG alpha activity. Springfield, IL: Thomas, 1974.

This handbook of references and synopses of scientific publications on human EEG alpha activity has been prepared to facilitate searches of the scientific literature for the many aspects and attributes of EEG alpha that are reported in numerous scientific journals crossing many and varied disciplines

The Alpha Syllabus is a compendium of recent reports containing significant information concerning EEG alpha. Scientific reports containing such information published prior to 1963 can be located in A KWIC Index of EEG Literature, published by Elsevier Publishing Company, 1965. For convenience, pre-1963 reports not contained in the Syllabus are listed alphabetically without abstracts in the Supplemental References.

Although an attempt was made to include as many publications as possible concerning EEG alpha, there are certain unavoidable omissions. These result from a variety of causes such as relative inaccessibility, unintentional oversights, and occasionally where the relationship of the report to alpha was obscure.

- 130 Brown, B. R., & Morgan, B. B., Jr. Studies of performance assessment and enhancement. (PR-73-24). Louisville, KY: Performance Research Laboratory, Graduate School, University of Louisville, June 1973. (DDC No. AD-773 045)

The report includes brief summaries of research activities under six major headings: studies of sustained performance: psychophysiological and biomedical correlates: personality, social and subjective correlates: technical studies and supporting laboratory research: methodological and theoretical formulations: and liaison activities. This study assessed the interaction of 36 hour sleep loss and continuous work with man's diurnal cycle, and also represented the first major application of the recently completed Digital Equipment Corporation PDP-12A Experimental Control System (ECS).

- 131 Brown, I. D., Simmonds, D. C. V., & Tickner, A. H. Measurement of control skills, vigilance, and performance on a subsidiary task during 12 hours of car driving. Ergonomics, 1967, 10, 665-673.

Eight subjects were given short driving tests at 0700, 1000, 1300, 1400, 1700 and 2000 hours on 2 days: (1) under experimental conditions of continuous driving and (2) under control conditions in which they carried on with their normal work between tests. Car control skills and performance on a subsidiary task of time-interval production were measured on a 2.2 mile test circuit in city traffic. Pulse rate and oral temperature were also recorded. Vigilance was measured during main-road driving on the experimental day by scoring time taken to respond to a light signal. Vigilance improved significantly during the spell of prolonged driving. Time-interval production was reliably more variable under experimental conditions than under control, but this difference was independent of the duration of the driving period. Differences in car-control skills between conditions were slight and statistically unreliable. These results support previous findings that a virtually continuous 12 hour period of driving during the normal working day need not affect either perceptual or motor skills adversely.

The apparent discrepancy between present findings, that performance on the subsidiary task was worse on the day of prolonged driving, and previous findings, that it tended to be better, is briefly discussed in relation to the general problem of measuring performance by the dual-task method.

- 132 Brown, J. D., & Huffman, W. J. Psychophysiological measures of drivers under actual driving conditions. Journal of Safety Research, 1972, 4, 172-178.

Tested 32 21-32 yr. old male drivers. One half with good and ½ with poor driving records. Heart, lateral eye movement, and GSR rates were measured, as well as accelerator reversal, brake response, and steering wheel reversal rates. Ss were tested during day and night driving sessions in (a) residential driving; (b) rural, 2-lane highway driving; (c) 4-lane expressway driving; and (d) 4-lane business district driving. Good drivers had significantly lower mean rates of GSR, accelerator reversals, and brake responses than poor drivers. Mean accelerator reversal and steering wheel reversal rates were higher during night than during daylight driving sessions; lateral eye movement and GSR rates were lower at night. Among the 4 traffic conditions, significant differences occurred for all measures except heart rate. Lateral eye movement and brake response rates were highest for residential driving and significantly different among all four conditions. GSR rate was significantly lower for rural driving than for the other three conditions; accelerator reversal rates were significantly higher for residential driving; steering wheel reversals were significantly higher for rural and expressway driving. Order of testing session, day or night 1st, was also found to affect Ss' responses.

- 133 Buchsbaum, M., & Fedio, P. Visual information and evoked responses from the left and right hemispheres. Electroencephalography and Clinical Neurophysiology, 1969, 26, 266-272.

Average evoked responses (AER) to verbal and non-verbal stimuli were recorded from left and right occipital EEG leads in ten normal right-handed subjects. Although the two types of stimuli were carefully matched for physical properties, their evoked potential wave forms could be differentiated by means of a computational technique utilizing replicate evoked responses. AER wave forms for verbal and non-verbal stimuli were more different from the left hemispheric lead than from the right. Verbal stimuli had shorter AER latencies.

Hemispheric differences in the AER are consistent with the hypothesis that the cerebral hemispheres in man assume an asymmetrical role in governing cognitive behavior.

- 134 Buchsbaum, M., & Fedio, P. Hemispheric differences in evoked potentials to verbal and nonverbal stimuli in the left and right visual fields. Physiology and Behavior, 1970, 5, 207-210.

Successive presentation of verbal and nonsense stimuli to right and left visual fields produced dissimilar evoked responses from the left and right occipital cortex in man. Stimulation of a dominant left hemiretina-hemisphere route yielded greater differences in evoked response waveform for the two classes of stimuli than the corresponding system on the right. Transmission of information via the direct visual pathways to each hemisphere also showed greater stability in evoked response activity than that from secondary or indirect pathways.

- 135 Buchsbaum, M., Gillin, J. C., & Pfefferbaum, A. Effect of sleep stage and stimulus intensity on auditory average evoked responses. Psychophysiology, 1975, 12, 707-712.

Auditory average evoked responses (AERs) to clicks ranging from 50 to 80 dB were studied in 9 normal adults while awake and during sleep. AER amplitude tended to increase little from 50 to 80 dB in waking subjects but increased markedly in sleeping subjects during stages 3 and 4. Rapid eye movement (REM) and stage 1 sleep had small amplitude AERs in comparison with other sleep stages. Individuals who showed decreases in amplitude at high intensities while awake slept significantly longer during the experimental nights.

- 136 Buchsbaum, M., & Silverman, J. Stimulus intensity control and the cortical evoked response. Psychosomatic Medicine, 1968, 30, 12-22.

Cortical evoked potentials to light flashes of 4 intensities and performances on a kinesthetic figural after-effects perceptual task (KFA) were obtained from normal and nonparanoid schizophrenic subjects. In previous studies it had been shown that individual differences in perception of stimulus intensity could be inferred from KFA performance. In this study, it was hypothesized that individuals whose KFA scores indicated a tendency to reduce the perceived intensity of strong stimulation would show a comparable response tendency on a cortical evoked response procedure. Significant correlations were found between evoked response latency and amplitude measures and KFA values in both normal and psychiatric groups. Sex differences in evoked response parameters were also found, males showing a steeper intensity-response function than females. Further, sex was found to be an important moderator variable of the relationship between evoked response measures and KFA values. These findings were interpreted in terms of a theoretical construct regarding a stimulus intensity control mechanism in the central nervous system.

- 137 Buchsbaum, M., Silverman, J., Henkin, R. I., & Pfefferbaum, A. Contrast effects on the auditory evoked response and its relation to psychophysical judgments. Perception & Psychophysics, 1971, 9, 379-384.

Used an auditory average evoked response (AER) procedure to search for a physiological counterpart of the contrast effect—the tendency for a S's judgment of the intensity of a stimulus to be modified by the intensity of prior stimulation. Ss were 10 male and 10 female 18-22 yr. old paid normal volunteers. When a tone was preceded by a softer tone, its AER amplitude increased; conversely, when a tone followed a louder tone, amplitude decreased. Irregular intervals between tones decreased the AER contrast effect, as did increasing the interval between tones. Significant correlations found between individual scores on the AER contrast procedure and performance on a battery of psychophysical tasks are discussed.

- 138 Buck, L. Reaction time as a measure of perceptual vigilance. Psychological Bulletin, 1966, 65, 291-304.

This article reviews the use made of reaction time as an index of performance deterioration in monitoring tasks, with special reference to the hypothesis that reaction time and detection rate are correlated indices of perceptual vigilance. It is concluded that this is the case, and a theoretical model relating the 2 indices to changes in vigilance occurring with time on task is proposed.

A section of this article reviews physiological correlates of perceptual vigilance.

- 139 Buck, M. D. Information processing and average brain potentials in man. (Doctoral dissertation, University of California at Los Angeles, 1972). Dissertation Abstracts International, 1973, 33, 3973B. (University Microfilms No. 73-1687)

Experiment I consisted of three conditions. The first condition was a control, requiring No Motor Response (NMR). The second condition required the appropriate right or left response, but the second stimulus (S2) delivered No Information (N). The third, or Information (I) condition, delivered information at S2 which allowed the subjects to prepare, during the S2-S3 interval, for the correct response following S3. The results from the second condition, No Information (N) demonstrated that the addition of a reaction time task to the basic three stimulus paradigm presented in condition one, No Motor Response (NMR) caused an increase in the amplitude of the slow negative potential shifts, or contingent negative variation (CNV) prior to S3, but S2 was not yet preceded by a large CNV, nor did it elicit a large evoked response. In the third, or Information (I) condition, the pitch of the second tone pip S2 delivered information corresponding to that in the arrow (S3), and a large CNV developed prior to S2, which now evoked a large vertex response, especially in the time period encompassing the late positive component or P300 wave.

Experiment II eliminated differential levels of arousal and attention, as indexed by the CNV prior to the second stimulus, by presenting four conditions in random sequence. A medium pitched warning tone S1 began every epoch. The No Information Left (NL) and No Information Right (NR) conditions were characterized by a medium pitched S2 which gave no information about the direction of the arrow S3. In the Information Right (IR) and Information Left (IL) conditions, the S2 was high or low pitched, respectively, allowing preparation for the appropriate response. The informational S2s evoked a larger P300 than the neutral S2s in all seven subjects. Laterality differences were exhibited in the form of larger CNVs over motor cortex preparing to respond, and larger P300 waves to S3 over motor cortex which did not respond.

Other results, including those regarding frontal potentials are presented and discussed.

- 140 Buck, R., Miller, R. E., & Caul, W. F. Heart rate and skin conductance responding during three attention-direction tasks. Psychonomic Science, 1969, 15, 291-292.

Subjects were instructed to turn their attention toward: (1) feeling their internal bodily events (BODY task); (2) remembering events that happened to them on the preceding day (COGNITIVE task); and (3) looking at a series of slides (EXTERNAL task). They were assured that no verbal report would be required. Cardiac deceleration occurred during the BODY and EXTERNAL tasks. The BODY task was associated with a decrease on skin conductance measures.

- 141 Bull, K., & Lang, P. J. Intensity judgments and physiological response amplitude. Psychophysiology, 1972, 9, 428-436.

Examined heart rate and cortical evoked responses to 5 sound intensities in 7 male undergraduates with normal hearing, who were instructed to judge intensity rank of each stimulus. The cortical potential exhibited a predominantly linear relationship to intensity, with larger responses evoked by louder tones. However, heart rate showed both a significant linear and a significant quadratic relationship. The latter tendency, for larger responses to occur for high and low tones, increased progressively over trial series. Results were paralleled by a quadratic relationship between stimulus intensity and judgment errors and between intensity and RT to stimulus offset (fewer errors and shorter latencies for high and low anchor tones). Findings show that both physical intensity and S's ability to discriminate stimuli modulated the amplitude of some physiological responses, and the latter factor increased in influence as S became more familiar with the stimulus set.

- 142 Bundy, R. S., & Fitzgerald, H. E. Stimulus specificity of electrodermal recovery time: An examination and reinterpretation of the evidence. Psychophysiology, 1975, 12, 406-411.

Two experiments were designed to test the hypothesis that skin conductance response recovery time can be (a) independent of other electrodermal measures and (b) responsive to particular stimulus manipulations when other measures of electrodermal activity are not. Experiment I employed a reaction time task. The results indicated that recovery time discriminated between the warning and execution signals only when the number of responses in the intertrial interval and preparatory interval differed. For those subjects who responded only to the signals, the recovery time was strongly correlated with the time since the previous response. In Experiment II each subject was presented three different stimulus conditions (mirror tracing, rest, and pressor). The recovery time did not discriminate between the stimulus conditions differently than other electrodermal measures. The results of these experiments suggest that the recovery time primarily reflects the amount of previous responding and is not independent of other electrodermal measures.

- 143 Burch, N. R., & Greiner, T. H. A bioelectric scale of human alertness: Concurrent recordings of the EEG and GSR. Psychiatric Research Reports, 1960, 12, 183-193.

A bioelectric scale of human alertness is derived for EEG major and minor period count as related to concurrent GSR amplitudes and count. While period counts of EEG are obtained automatically, and can be equated directly to dominant and superimposed frequency, the interpretation of GSR as a measure of alertness depends upon distinguishing between GSRs to specific stimuli and those of non-specific origin. GSR response to specific stimuli is considered a measure of performance reflecting alertness. Both non-specific GSR count and left P-O EEG minor period count show a monotonic increase with arousal, and appear to reflect the same aspect of neurophysiologic status. Both EEG major period count and specific GSR amplitude follow a bell-shaped curve except for the paradoxical spike (in the period of light sleep) that has confused GSR interpretation so much in the past.

- 144 Burger, G. C. Heart rate and the concept of circulatory load. Ergonomics, 1969, 12, 857-864.

The functional demands of different types of work-load (dynamic and static muscular work, exposure to extreme hot or cold climates and the mental load caused by emotional stress and by the processing of information) are discussed in this paper. The need for absolute and comparative or relative measurement or estimation of these functional physiological demands in different work situations are considered. The validity of oxygen consumption of the body and of heart rate as an integral ergonomics measure are critically discussed. It is pointed out that these measures have only a high validity when (heavy) dynamic muscular work is considered. However, in muscular work of a static type and in the other types of work-load mentioned (climatic and mental conditions) there are many restrictions on their validity.

Moreover, from the point of view of occupational medicine and ergonomics there is a need for specific knowledge about the load of different organic (functional) systems. Therefore, the concept of circulatory load is put forward and its value as an ergonomics measure is advocated.

The use of heart rate alone as a measure of circulatory load has a rather restricted value. It is shown that the intrinsic value of each heartbeat as a measure of circulatory load differs greatly in different types of work-load, since apart from heart rate, stroke-volume and mean blood pressure show various patterns of reaction in these conditions.

The possibilities of exact measurement of these data in the practical work situation, however, are still rather limited. Nevertheless, when using heart rate as an ergonomics measure, these additional quantitative data determining the circulatory load and their reactions on different types of work-load should be carefully estimated and taken into account as much as possible.

- 145 Burgess, M., & Hokanson, J. E. Effects of increased heart rate on intellectual performance. Journal of Abnormal and Social Psychology, 1964, 68, 85-91.

A significant correlation found in a pilot study between heart rate and Digit Symbol performance was utilized to investigate effects of type of arousal induction on performance. Sixty Ss were arranged in a 3 X 2 factorial design, divided into high and low drive via heart rate. Ss first performed on a Digit Symbol task; followed by a frustrating experience, physical exertion, or nonfrustrating task; followed by readministration of an alternate form of the 1st Digit Symbol problem. The results showed that the relation between activation and performance, in most instances followed the hypothetical inverted U function.

- 146 Burgess, M. M., & Hokanson, J. E. Effects of autonomic arousal level, sex and frustration on performance. Perceptual & Motor Skills, 1968, 26, 919-930.

Investigated the effects of initial heart rate level (drive), sex and frustration on symbol-matching performance in 176 students. Low (LD), moderately low (MLD), moderately high (MHD), and high (HD) heart-rate Ss worked on a modified digit-symbol problem before and after a frustration or no-frustration manipulation which raised heart rate on the average 20.6 and 2.96 beats/min respectively. The results show that MHD and HD Ss complete significantly more matches initially than LD and MLD Ss by manifesting both shorter response and intertrial interval latencies. Furthermore, frustration induced autonomic arousal facilitates performance improvement for LD and MLD Ss and decelerates performance improvement for MHD and HD Ss. Frustration-induced arousal exerts this effect by altering response latency only. No sex differences were observed.

- 147 Burns, N. M., Baker, C. A., Simonson, E., & Keiper, C. Electrocardiogram changes in prolonged automobile driving. Perceptual & Motor Skills, 1966, 23, 210.

Exploratory work investigated electrocardiogram (ECG) changes during nearly continuous driving over distances of 200-700 miles. Data were obtained for a total of 6000 miles of driving. The electrical activity of the heart was noted to respond distinctly to duration of driving and critical road situations. It appears that significant ECG changes may occur in healthy Ss during long distance driving which would be considered abnormal in response to other stress situations.

- 148 Burns, S. K., & Melzack, R. A method for analyzing variations in evoked responses. Electroencephalography and Clinical Neurophysiology, 1966, 20, 407-409.

This study illustrates two examples in which the usual assumption of an unchanging probability distribution made to justify averaging is not true. In both the behaving animal and the sleeping human subject large changes in the amplitude and wave shape of the evoked response occur in the time needed to obtain an average with a reasonably large signal-to-noise ratio. This result points out the risk in inferring a causal relationship between a behavioral manipulation or observation and a change from one average to another in the amplitude or wave shape of the averaged evoked response.

- 149 Busk, J., & Galbraith, G. C. EEG correlates of visual-motor practice in man. Electroencephalography & Clinical Neurophysiology, 1975, 38, 415-422.

Special analysis of EEG signals was performed for 15 male undergraduates engaged in 3 motor tasks of differing difficulty—eye, hand, and eye—hand tracking. A measure of average weighted coherence (C) was computed between the 6 possible combinations of 4 scalp areas: O₂, C₃, C₄ and F_z. In all Ss, regardless of task, scalp recordings over cortical areas known to have relatively dense fiber connections had significantly greater C values. However, the effects of task difficulty and practice were superimposed upon this basic pattern. Thus, the most difficult task (pursuit-rotor tracking) resulted in the highest coherence levels, while the least difficult task (visual tracking only of the pursuit-rotor disk) resulted in the lowest coherence levels. Practice, on the other hand, was associated with a significant decrease in overall level of coherence. This decrease is consistent with an interpretation of reduced task difficulty due to visual-motor learning. Results suggest that patterns of scalp EEG coherence may reflect some aspects of the underlying pattern of anatomical pathways, as well as the more dynamic properties of task difficulty and visual-motor practice.

- 150 Butler, R. A. The auditory evoked response to stimuli producing periodicity pitch. Psychophysiology, 1972, 9, 233-237.

The cortical evoked response in man to an amplitude modulated complex sound was investigated in order to find out whether the response reflects the acoustic spectrum of the stimulus or its modulation rate. The complex sound consisted of a train of square waves repeated 200 times a second and filtered so that only the acoustic energy confined predominantly to the region of 1000 Hz was delivered to the listener. Perceptually, the pitch of this complex sound is in the neighborhood of 200 Hz.

The results from 10 listeners, tested repeatedly, showed that the presence of 1000-Hz tones interposed between successive presentations of the periodic complex stimulus served to habituate the response to the latter; intervening 200-Hz tones exerted relatively little effect on the responsiveness to the periodic stimulus.

These data suggest that periodicity differences in stimulation at the periphery are not converted into place differences at the level of the auditory cortex; that a low-pitched sound is not necessarily mediated by those neural units maximally responsive to low frequency sinusoids.

- 151 Butler, R. A., Keidel, W. D., & Spreng, M. An investigation of the human cortical evoked potential under conditions of monaural and binaural stimulation. Acta Oto-Laryngologica, 1969, 68, 317-326.

The human cortical potential evoked by a 1000-Hz tone was recorded under conditions of binaural and monaural stimulation which covered a wide range of stimulus intensities. The results showed that (1) the curve for the amplitude as well as for the area confined by the potential increased with increases in stimulus intensity. At higher stimulus intensities, these curves leveled off. (2) Bilateral stimulation generated larger cortical potentials than did monaural stimulation. (3) Latency of the potential decreased with increases in stimulus intensity. When the monaural stimulus was delivered to the ear contralateral to the active scalp electrode, the various components of the potential showed consistently a shorter latency than when the monaural stimulus was presented ipsilaterally.

- 152 Butler, S. R., & Glass, A. Alpha rhythm and fine eye and eyelid movement. Nature, 1970, 228, 1110-1112.

These findings are inconsistent in a number of respects with the view of ocular tremor as a generator of alpha rhythm. The predominant frequencies of ocular tremor are markedly different from those of simultaneously recorded alpha rhythm. The random components of ocular movement contrast with the redundancy of the alpha rhythm; one would expect coherent signals originating in the orbit to be obscured by superimposition of neuronal activity when measured at the scalp. In fact, the reverse is observed. Even if, in the present study, the eyeball were oscillating at alpha frequency under the closed lid, such movement is evidently not essential for the appearance of alpha rhythm at the scalp. In view of the relationship between the amplitude of saccades and the artefacts they induce in the EEG, one would expect to record very conspicuous tremor of the eyeball when alpha rhythm occurred with the eyes open. This was not the case.

Although these findings seem to preclude an orbital origin for the alpha rhythm, the cross correlations argue for a weak interaction in the opposite direction. That is to say, eye movement may be modulated by alpha rhythm. This will occur when conscious control of fixation wanes or is interrupted by eye closure.

- 153 Butler, S. R., & Glass, A. Inter-hemispheric asymmetry of contingent negative variation during numeric operations. Electroencephalography and Clinical Neurophysiology, 1971, 30, 366. (Abstract)

Contingent negative variation (CNV) associated with the exposure of the numeral was compared over left and right parietal and frontal regions. The amplitude of the CNV was significantly greater over the left hemisphere, and its onset sooner, in right-handed subjects while the effect was reversed in the one left-handed subject in the study. In only 1 out of 13 subjects was the amplitude of the CNV greater over the putatively non-dominant hemisphere and then marginally so. The data are taken to support a view of the functional asymmetry of the cerebral hemispheres for some processes of mental arithmetic in that the state of expectancy of the hemisphere doing the work is greater than that of the other hemisphere. The results are compared with a parallel study which demonstrated differences in the amplitude histogram of the EEG over left and right hemispheres during calculation.

C

- 184 Cael, W. W., Nash, A., & Singer, J. J. The late positive components of the human EEG in a signal detection task. Neuropsychologia, 1974, 12, 385-387.

Attempted to replicate a study by S. Hillyard et al (1971) which used human Ss in a signal detection task and obtained a prominent late positive component (LPC) of the EEG only in the Hit category of responses. They concluded that the LPC reflected S's degree of certainty that a signal has occurred. In contrast the present study, which used 8 undergraduates, found that the LPC occurred in the Hit, Miss and Correct Rejection categories of responses, thereby supporting the hypothesis that the LPC is a correlate of uncertainty reduction and does not directly depend on the physical presence of the signal.

- 185 Caille, E. J. Contribution a l'etude des processus de vigilance: Approche psychophysiologique de la veille radar. [Study of the process of alertness: Psychophysiological approach to radar watch.] Proceedings of Second International Congress on Ergonomics, Dortmund, 1964, 231-235.

The search for better predictors of alertness, it seems to us, should be aimed in two directions: more detailed analysis of the components of the personality of the operator, and the automatic analysis of the electrophysiological potentials resulting in the matching of the subject to the task (particularly EEG). This requires the collaboration of trained clinical psychologists, on the one hand, and neurophysiologists supported by electronics experts up-to-date in the methods of trace analysis by auto- and cross-correlation, on the other.

Thus, objective predictors could be identified which will lead to the establishment of an intercorrelation matrix and the determination of their hierarchy using the method of multiple correlation coefficients.

Thus, the processes of alertness would be studied from an overall perspective, likely to be exhaustive, and without preconceived ideas in the choice of parameters subject to experimentation.

- 186 Caille, E. J. Psychophysiologie de la veille-radar. [Psychophysiology of radar-viewing]. Travail Humain, 1964, 28, 143-144. (Abstract)

Within all individuals there was a significant increase in the duration of alpha from the first to the third watch. The occipital rhythm became more and more frequent in the course of the test.

This increase was not accompanied by a significant decrease in the rate of detections.

Exploratory eye movements progressively disappeared during the first hour of the watch.

The amplitude of plethysmographic oscillations regularly decreased, indicating a certain adaptation to the watch: it should be noted that this task was more monotonous and less stressful than a normal operational watch.

- 187 Caille, E. J., & Bassano, J. L. Biorhythm and watch rhythms: Hemeral watch rhythm and anhemeral watch rhythm in simulated permanent duty. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

The simulation of a 30-day submarine submersion with a volunteer crew of 24 men provided the framework for a comparison between two work/rest cycles within a crossover balanced design: a 72-hour period rhythm, as practiced in the Navy, with 4 hours of sleep shifting or sleep splitting in cyclic transposition for each third part of the crew; and a 24-hour period rhythm, with permanent 8 hours or 16 hours of sleep shifting for each third part of the crew.

The strong advantage of the second alternative compared to the first is evidenced in the sleep process, behavioral efficiency, mood, and circadian biochemical parameters.

- 188 Caille, E. J. P., Bock, G., Goybet, P., Requin, J., & Roman, C. Problemes methodologiques poses par l'etude psychophysique du niveau d'efficience dans les taches de guidage. [Methodological problems encountered in the psychophysiological study of efficiency level in guidance tasks.] Actes du Troisieme Congres de la Societe d'Ergonomie de Langue Francaise, Bruxelles: Presses Universitaires de Bruxelles, 1968.

This report presents evidence that a spectral density analysis of EEG data is superior to an auto-correlation analysis in assessing variations in vigilance level.

- 189 Caille, E. J. P., Quideau, A. M. C., Girard, J. F. J., Grubar, J. C., & Monteil, A. C. Loss of sleep and combat efficiency: Effects of work/rest cycle. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

A 64 hours to 72 hours sleep loss did not severely impair the fighting capabilities of a small volunteer group of well trained and well motivated enlisted men. Only long-term memory and decision making proved to be very sensitive to such a deprivation. Between-subject differences were brought out particularly clearly when 2 x 12, 2 x 6 and 6 x 4 work/rest cycles were followed; these differences were more marked during night-work than during day-work.

Consequently, if the military authorities require the members of a group to display homogeneous capabilities, it would be advantageous to adopt a 3 x 8 work/rest cycle, since this minimizes the between-subject differences. If, however, there is a requirement for men who are able to sustain high levels of performance when working either on 2 x 12, 2 x 6 or 6 x 4 cycles, it is recommended that individuals should be selected according to psychological and physiological criteria described in the present investigation, which have been shown to be statistically reliable.

- 100 Callaway, E., III Factors influencing the relationship between alpha activity and visual reaction time. Electroencephalography and Clinical Neurophysiology, 1962, 14, 674-682.

Studies have been reported concerning the relationship between alpha activity and visual reaction time. Evidence is presented to indicate that for a given individual there is an enduring tendency for particular phases of the alpha cycle to be associated with fastest or slowest reaction times. Evidence is also presented to indicate that the alpha phase at which stimulation evokes slowest reaction time is not 'significant' or consistently shifted by altering the stimulus intensity. This would suggest that alpha phase may be indirectly related to cortical excitability, and stimulus intensity may alter this relationship; or else that alpha phase may become related to reaction time much earlier in the course of neural events than has been suspected.

- 101 Callaway, E., III. Response speed, the EEG alpha cycle, and the autonomic cardiovascular cycle. In A.T. Welford & J. E. Birren (Eds.), Behaviour, aging, and the nervous system. Springfield, Ill.: Thomas, 1965.

Alpha cycle influences responses to visual stimuli early in the course of neural events. It influences reaction time and brightness judgment, but the phase relationships are variable. By contrast, the autonomic cardiovascular cycle influences only reaction time and is independent of stimulus modality. It appears to reflect a wave of motor inhibition paralleling sinus and vagal autonomic afferent discharge.

- 102 Callaway, E., III, & Layne, R. S. Interaction between the visual evoked response and two spontaneous biological rhythms: The EEG alpha cycle and the cardiac arousal cycle. Annals of the New York Academy of Sciences, 1964, 112, 421-431

In studying alpha cycles, we find changes in the visual evoked response that parallel changes in behavior. However, it can be shown that alpha phase influences reaction time early in the course of neural events leading from stimulus to response. For the cardiac arousal cycles, there are no changes in visual evoked response that parallel behavior. Lacey found evidence that arousal increases motor readiness. Perhaps our findings indicate that the cardiac arousal cycle influences simple reaction time quite late in the course of neural events—that is to say, by influencing motor readiness. If this is true, perhaps if we time-lock our averaging to the motor output instead of to the sensory input, we might find consistent cardiac arousal cycle changes from person to person.

- 103 Callaway, E., III, & Yeager, C. L. Relationship between reaction time and electroencephalographic alpha phase. Science, 1960, 132, 1765-1766.

Demonstrations of a relationship between human 8 to 13 per second (alpha) electroencephalographic activity and simple visual reaction time can be made at reliable levels of confidence by (i) sampling reaction times to stimuli given at phases of the alpha cycle 10 msec apart, (ii) selecting the phase with the slowest reaction times, and (iii) collecting enough reaction times to stimuli at this and some other control phase for statistical comparison.

- 164 Campos, J. J., & Johnson, H. J. The effects of verbalization instructions and visual attention on heart rate and skin conductance. Psychophysiology, 1966, 2, 305-310.

Investigated the effects of verbalization instructions and amount of visual attention on direction of change of heart rate (HR) and skin conductance (SC). Little evidence for directional fractionation of SC and HR was found with the conditions used. The variable of verbalization instructions produced a highly significant effect on HR and SC, and conditions of no-verbalization produced a consistent but nonsignificant decrement in HR. Other degrees of verbalization produced increments in HR. A visual attention variable produced no significant effect on either HR or SC, although means were arranged in order of increasing activation with increase in visual attention (stimulus complexity). Results are interpreted as being opposed to an intake-rejection hypothesis such as has been proposed by Lacey to account for directional fractionation of response and for HR decrements. Instead, it is suggested that the requirement to verbalize can produce important changes in degree and direction of autonomic activation.

- 165 Campos, J. J., & Johnson, H. J. Affect, verbalization, and directional fractionation of autonomic responses. Psychophysiology, 1967, 3, 285-290.

An experiment was designed to evaluate the effects of pleasantness and unpleasantness and instructions to verbalize on directional fractionation of autonomic response. Degrees of pleasant and unpleasant stimulation were presented to Ss under two verbalization instruction conditions. Something like directional fractionation was found for the very unpleasant no-verbalization condition only, but the pattern disappeared upon the addition of a later-verbalization requirement. More generally, it was found without exception that conditions of no verbalization are accompanied by cardiac deceleration, regardless of degree or of quality of affect, while later verbalization conditions produce cardiac acceleration, again regardless of degree or quality of affect. The authors conclude that verbalization instructions are important for determining the degree and direction of cardiac activation.

- 166 Cannings, R., Borland, R. G., Hill, L. E., & Nicholson, A. N. Pitch and formant analysis of the voice in the investigation of pilot workload. In K. E. Klein (Ed.), Methods to assess workload. AGARD Conference Preprint, No. 216, 1977. (Available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.)

In view of these considerations the approach adopted for the present study was to use computer techniques to extract parameters from the speech waveform which would be amenable to statistical analysis, and to compare the structure of a pilot's speech waveform at different points in the flight profile. Physiological data and subjective assessments may be used to indicate the workload of the flight profile, and so it should be possible to correlate voice parameters with known workload. In the present study we concentrated on the call sign of British Airways - "Speedbird", and by using a single word, both pitch and formant information has been analyzed.

- 167 Cant, B. R., & Bickford, R. G. The effect of motivation on the contingent negative variation (CNV). Electroencephalography and Clinical Neurophysiology, 1967, 23, 594. (Abstract)

The reaction time associated with the avoidance paradigm was significantly different from that in the other two operant paradigms.

These experiments show that whereas a subsequent noxious stimulus increases the CNV most in the central and parietal areas, its avoidance has the most effect on the frontal CNV. This suggests that the CNV may not be a unitary process, and that sensory and motivational effects may be mediated by different mechanisms.

- 168 Caperell, C., & Shucard, D. W. The visual evoked potential as an index of cerebral lateralization of cognitive processing. Psychophysiology, 1977, 14, 90-91. (Abstract)

Recently, investigators have attempted to study hemispheric functional specialization in intact individuals using electrophysiological techniques. The findings of these investigations, although tending to support the clinical evidence, have not been clearly convincing. In an attempt to overcome some of the difficulties present in previous studies, we utilized a paradigm in which the visual evoked potential (VEP) was used as a probe to assess hemispheric functional specialization during conditions of ongoing cognitive processing of information.

Subjects were musically naive college students who were strongly right-handed. Determination of handedness was based on a series of behavioral tests. Temporal and parietal VEPs to irrelevant flash stimuli were obtained while subjects were engaged in Mental Arithmetic, Musical Pattern Recognition, and Attention to Breathing tasks. The procedure allowed the experimenter to carefully monitor the subject's involvement in the task through continuous checks on performance, and also provided controls for movement, expectancy effects, and evoked offset responses. Only data from those subjects performing adequately on all three cognitive tasks were included in the final analysis.

Analysis of the data indicated that the amplitude of the VEP to an irrelevant (probe) stimulus was attenuated in the hemisphere most involved in the ongoing cognitive processing. That is, differences in amplitude between right and left hemispheric VEPs showed significant changes across the experimental conditions, with the right-sided VEP showing a higher relative amplitude than the left during Mental Arithmetic as compared to Musical Pattern Recognition. These findings were most pronounced for the temporal placements. The results suggest that the lateralization of ongoing cognitive processing can be demonstrated in a paradigm such as this, and that the VEP used in the manner described may indeed provide a useful technique in studying this phenomenon.

- 169 Carpenter, A. The rate of blinking during prolonged visual search. Journal of Experimental Psychology, 1948, 38, 587-591.

An experiment is described, in which the rate of blinking increased by 43 percent, during the performance of a two-hour watchkeeping task. This is submitted as evidence that the rate of blinking can be used as a criterion of visual efficiency.

- 170 Carriero, N. J. Physiological correlates of performance in a long duration repetitive visual task. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

This study examined the effectiveness of heart activity (HR), respiration (RESP), muscle activity (EMG), skin conductance (SCL), and brain wave activity (EEG) as discriminators of correct vs. incorrect performance in a repetitive visual task of approximately two hours duration. Separate analyses were made of the data to distinguish the operation of task difficulty from performance accuracy. In addition, both of the analyses were repeated using standard score transforms of the raw data to compensate for individual differences. An interactive statistical design was employed in order to assess the differential changes of the physiological variables with accuracy over time. This design proved to be of crucial importance to assessing this relationship since the accuracy main effect for RESP, EMG and HR was non-significant in all four data treatments. The accuracy-by-time interactions were significant in a number of instances and established the efficacy of these parameters as discriminators of performance adequacy. Additionally, the standard score transforms proved essential to establishing these relationships when the variance in task difficulty was eliminated. The implication of these findings for the development of an alertness indicator is also discussed.

- 171 Carriero, N. J., & Fike, J., Jr. Cardiac deceleration as an indicator of correct performance. Perceptual and Motor Skills, 1977, 44, 275-282.

A within-S experiment involving 10 Ss was performed to examine the relationship between the accuracy of position judgment and cardiac deceleration. The results supported the hypothesis that accurate (correct) performance is accompanied by greater cardiac deceleration than inaccurate performance for those Ss (9 out of 10) who exhibit cardiac deceleration to stimulus onset. The data indicated, however, that the relationship varies with time. Part of this variability appears to be due to the initial exploratory behavior that Ss engaged in and later reported during the post-experiment interview.

- 172 Carroll, D. Physiological response to relevant and irrelevant stimuli in a simple reaction time situation. In A. T. Welford (Ed.), Man under stress. New York: John Wiley & Sons, 1974.

Simple reaction time to a light was measured under two conditions: (a) with an intense (100 db) or moderate (50 db) auditory stimulus always coming 5 sec before the light; and (b) with a random relationship between the times at which the auditory stimuli and lights occurred. Response times showed relationships with a physiological measure of autonomic response. The results are discussed in terms of: (i) orienting and defence reactions to potentially stressful stimuli, and (ii) intense auditory stimuli as stressors.

- 173 Chapanis, A. The search for relevance in applied research. In W. Singleton, J. Fox & D. Whitfield (Eds.), Measurement of man at work. London: Taylor and Francis, 1971.

A portion of this paper deals with the relationship between physiological variables and performance on arithmetic and probability monitoring tasks.

- 174 Chapman, R. M. Evoked responses to relevant and irrelevant visual stimuli while problem solving. Proceedings of the 73rd Annual Convention of the American Psychological Association, 1965, 177-178. (Summary)

The results of both experiments support the interpretation that evoked responses are larger when the stimuli are relevant to the task and, in addition, that evoked responses are larger for stimuli with more complex shapes.

- 175 Chapman, R. M. Evoked potentials of the brain related to thinking. In F. J. McGugian & R. A. Schoonover (Eds.), The psychophysiology of thinking. New York and London: Academic Press, 1973.

In summary, sensitivity to the details of mental behavior and correspondence in time, recommend the averaged evoked potential as a good candidate for studying the psychophysiology of thinking. Rather subtle changes in task requirements are correlated with AEP changes. These changes occur within a fraction of a second. Furthermore, the AEP is composed of a rich number of components, about 15 orthogonal ones in our relatively simple experimental situation. The AEP effects may be related not only to prestimulus processes, but also to poststimulus processes. Consequently, simple hypotheses such as attention or arousal are not sufficient to explain the AEP effects. It is necessary to consider more refined operators which have properties of discrimination of stimulus classes within a sensory modality, quick change, and response differentiation.

- 176 Chapman, R. M., Armington, J. C., & Bragdon, H. R. A quantitative survey of kappa and alpha EEG activity. Electroencephalography and Clinical Neurophysiology, 1962, 14, 858-868.

The distribution of kappa scores suggests that differences between subjects are quantitative rather than qualitative. Hard tasks, such as adding, tended to give higher kappa scores and lower alpha scores than easy tasks, such as counting and keeping a "blank mind". The increase in kappa activity on hard tasks was found both with eyes closed and eyes open, whereas the decrease in alpha activity on hard tasks was found only when the eyes were closed. Regardless of task difficulty, both alpha and kappa scores tended to be higher when the eyes were closed than when they were open. The effect of eye condition was much greater on the alpha scores than on the kappa scores. The EEG scores and the findings were highly reliable.

Evidence supporting the distinction between kappa and alpha EEG activities was presented. Simultaneous kappa and alpha scores were quantitatively accounted for by assuming that the kappa and alpha activities are independent and occur simultaneously by chance.

- 177 Chapman, R. M., & Bragdon, H. R. Evoked responses to numerical and nonnumerical visual stimuli while problem solving. Nature, 1964, 203, 1155-1157.

The main finding appears to be general. Larger evoked responses were obtained to number stimuli than to blank stimuli in all persons tested.

A variety of control runs have been made. The effect of a different irrelevant stimulus and different sequences of stimuli are illustrated. A plus sign (+) was used because it was similar to the number stimuli in having approximately the same luminance and general meaning by virtue of the subject's language history. When a plus was used in the second position in place of a blank, the response tended to be larger and have a waveform more like the number response. Nevertheless, the response to the irrelevant plus was smaller than the response to the relevant number. When a plus was used in the first position, its response was larger. It is suggested that its task relevance is increased in this position in that it signifies the start of each trial.

- 178 Chapman, R. M., Shelburne, S. A., Jr., & Bragdon, H. R. EEG alpha activity influenced by visual input and not by eye position. Electroencephalography and Clinical Neurophysiology, 1970, 28, 183-189.

Recent investigations have suggested that evaluation of the eyes is associated with a marked increase in EEG alpha activity. Our experiments showed that vertical eye elevation had no direct influence on alpha activity. In Preliminary and Main Groups of thirteen and twenty-two subjects, an EEG electronic scorer was used to measure the amount of time that alpha activity was present from the left and right hemispheres in the following comparisons: (a) eye positions ahead vs. up in the light, (b) eyes ahead vs. up in the dark and (c) eyes open vs. closed in the light. In the Main Group, fixation targets for the eye ahead and eye-up positions and electro-oculogram records of eye position were added. In the dark, where differential visual input was eliminated, the alpha index did not increase when the eyes were elevated. Differences in alpha activity related to eye position in the light condition were decreased when differential visual input was decreased by the use of fixation targets. The effects of variables confounded with eye position, e.g. patterned visual input to the retina, accommodation, fixation, and effort required to maintain a specified eye position, are discussed. In these experiments, the main variable that determined increase in alpha activity was reduction in visual input, either by closing the eyes or extinguishing the lights.

- 179 Chase, W. G., Graham, F. K., & Graham D. T. Components of HR response in anticipation of reaction time and exercise tasks. Journal of Experimental Psychology, 1968, 76, 642-648.

Examined cardiac rate changes during the 4-sec fore-period of an RT task involving either exercise or the traditional button push response. Three components of the heart rate response were identified: (1) an initial deceleration to the ready signal, (2) an intermediate component which stabilized below prestimulus level in anticipation of a button push but accelerated in anticipation of exercise, and (3) a deceleration immediately preceding the go signal. The initial deceleration appeared to be an unconditioned orienting reflex to the ready signal and the deceleration preceding the go signal, a conditional attention response. It is suggested that energy and stimulus reception requirements determined cardiac responses.

- 180 Chose, W. G., Graham, F. K., & Graham, D. T. Components of HR response on anticipation of reaction time and exercise tasks. Psychophysiology, 1968, 4, 503. (Abstract)

Tested whether or not preceding acceleration is necessary for deceleration by using a ready signal that elicited only deceleration in a nonsignal situation and whether anticipated energy expenditure affects the heart rate (HR). Two experiments, one a between S and one a within-S design, examined HR change during the 4-sec foreperiod of an RT task involving either exercise or the button-push response. The HR curve for both experiments showed a cubic trend which accounted for 99% and 96%, respectively, of the seconds variance and included (1) immediate deceleration that appeared to be an unconditioned orienting reflex to the ready signal, (2) stabilization or acceleration depending upon the task, and (3) deceleration preceding the go signal, presumably a conditioned "attention" response. The tasks effect was demonstrated by a significant difference in linear trend that accounted for 93 and 86% of the tasks by seconds variance. Results indicate that the response is a function both of anticipated energy requirements and of stimulus reception requirements.

- 181 Christie, B., Delafield, G., Lucas, B., Winwood, M., & Gale, A. Stimulus complexity and the EEG: Differential effects of the number and the variety of display elements. Canadian Journal of Psychology, 1972, 26, 155-170.

Berlyne (1960, 1963a, 1967) has suggested that the collative properties of stimulation, including stimulus complexity, can affect the arousal level of an observer. Several previous experiments have demonstrated that stimulus complexity does affect the EEG (e.g. Berlyne & McDonnell, 1965; Baker & Franken, 1967; Berlyne et al., 1967; Gale, Dunkin, & Coles, 1969; Gale, Christie & Penfold, 1971). However, many of these experiments confounded different dimensions of stimulus complexity. Furthermore, all failed to demonstrate that perceived complexity varied in accordance with the independent variable. The present experiments do not suffer from those weaknesses, or from several others which characterize many of the previous experiments. It is concluded that the number and the variety of elements in a visual display are two dimensions of stimulus complexity which may affect the EEG in different ways.

- 182 Chuprikova, N. I. Issledovanie vyzvannykh potentsialov u cheloveka i fiziologicheskie korrelyaty vnimaniya i proizvol'nykh dyigatel'nykh reaktsii. [The study of evoked potentials in man and the physiological correlates of attention and voluntary motor responses.] Voprosy Psikhologii, 1967, 13, 175-183.

A review of non-Russian research on evoked potentials and attention in man.

- 183 Ciganek, L. The effects of attention and distraction on the visual evoked potential in man: A preliminary report. Electroencephalography and Clinical Neurophysiology, 1967, Supplement 26, 70-73.

The effects of attention and distraction on the visual evoked potential were investigated in twelve normal subjects. Single and double flashes were used. In general, the amplitudes of the responses during attention were significantly greater. Opposite results were possible but less frequent. The enhancing effect of attention was different for the various waves. Some waves were even regularly depressed during attention. The effects of attention and distraction were more pronounced in the second facilitated response to double flashes, again with the exception of some waves. The possible significance of these events is discussed.

- 184 Ciganek, L. Variability of the human visual evoked potential: Normative data. Electroencephalography and Clinical Neurophysiology, 1969, 27, 35-42.

1. Visual evoked responses of twenty normal subjects (50 from each of them) were recorded, graphically digitalized and studied by means of digital computer techniques, mainly for their variability.

2. The amplitude variability of the individual average responses - averaged from the 50 single responses of each subject - is due mainly to the background activity, the variability of the evoked potential being mostly negligible. In about one half of the subjects there is a significant decrease of variability about 80 msec after the stimulus, due to blocking of background activity. Other significant short oscillations in variability of less clear origin are described and discussed.

3. The average group response (across the whole group of subjects) supports the existence of a standard, though inter-individually very variable, human visual evoked potential. The dispersion of the amplitudes of the individual average responses about the average group responses rises with the wave latency.

4. With the method used it is possible to compute the probability with which a particular wave of the average response is due to the evoked potential or to noise (background activity). Examples are given mainly in connection with the problem of reliability of low voltage, short latency waves of the EEG response.

5. The latency variability is greater with long than with short latency waves. There is also a slight increase in variability in the initial short latency waves (I and II) but this is probably due to the background constituent as these evoked potential waves are of low voltage.

- 185 Ciganeck, L. Visually evoked potential correlates of attention and distraction in man. Psychiatria Clinica, 1969, 2, 95-108.

The majority of the constituents of the visual evoked potential in man present significantly higher amplitudes with attention than with distraction. Some definite components (waves V and Va) present a clear opposite tendency. All described changes are variable from S to S and in the same S from 1 measurement to another. The described effects are more pronounced with the 2nd facilitated response to the double flash and less pronounced with lower stimulus intensity. Results suggest existence of a rather large number of uncontrolled factors influencing the amplitude of the evoked potentials.

- 186 Ciofu, I. Le rendement de la memoire involontaire par rapport a la memoire volontaire et la concentration de l'attention. [The effectiveness of involuntary memory in relation to voluntary memory and concentration of attention.] Revue Roumaine des Sciences Sociales: Serie de Psychologie, 1968, 12, 55-73.

One of three variants (words, numbers, geometric figures) is applied to each of three groups, each composed of 12 Ss who are tested singly and only once in 2 phases to determine: (a) in what way the involuntary memorization (IM) of the marginal elements (a letter, a number, and a simple geometric figure, all equal in size) in the task is a function of the difficulty (easy, average, difficult) of the variant ("central element") to be memorized voluntarily, and (b) whether memorization performances correlate with bioelectric findings (EEG, GSR, electro-oculogram) on visual perception, and the amount of attention or effort during the activity. Results indicate that mechanisms common to perception and memorization are able to assume a different role, depending on the performance level. What appears to be memorization in the early stages is actually perception followed by comprehension. This also takes into account the transfer of attention from 1 element to another during VM or IM, as well as the commutation of attention from 1 psychological process to another (perception to memorization and vice versa), accomplished in a nondeliberative manner. A hypothesis for improving IM, based on evidence of greater efficiency during the IM of variants of average difficulty with an average effort, is advanced.

- 187 Ciofu, I., & Floru, R. Electroencephalographic investigations of set. Revue Roumaine des Sciences Sociales: Serie de Psychologie, 1965, 9, 195-210.

Experiments on 24 normal Ss with bioelectrical correlates of set (general and selective) indicate that: (1) the rest EEG was desynchronized and the photic potentials were facilitated after the S was instructed that he had to perform various tasks when hearing certain acoustic stimuli; (2) after elaboration of a set (perceptual, motor, intellectual) to coupled positive tones, differentiated from coupled negative ones, the photic potentials were facilitated in the foreperiod of the relevant signal (the 2nd tone); (3) when repeating the same task, the period of activation corresponding to the set became shorter; and (4) different degrees of arousal in relation to the difficulty of the task were observed.

- 108 Ciofu, I., & Milcu, A. Contributii la studiul mecanismelor neurofiziologice ale atentiei: III. Cercetari electroencefalografice cu privire la fenomenul de "obisnuinta" la om. [Contributions to the study of the neurophysiological mechanisms of attention: III. EEG research on "habituation" in men.] Revista de Psihologie, 1965, 11, 387-404.

Study of the appearance and dynamics of habituation in adult Ss, who were instructed to perform several tasks involving perception, motor-reactions, and mental operations. Auditory stimuli were used as signals. Often the habituation was studied simultaneously with intermittent photic stimulation. EEG expression of the habituation was noticed in almost all the experimental conditions, its modification depending on: (1) the type of stimuli, and (2) stimuli difficulty and significance (positive or negative). By repeating the same test, certain moments in the evolution of habituation were observed. The dishabituation where positive stimuli were used occurred quickly and was relatively stable.

- 109 Clynes, M., & Kohn, M. Spatial visual evoked potentials as physiologic language elements for color and field structure. Electroencephalography and Clinical Neurophysiology, 1967 Supplement 26, 82-96.

Visual evoked potentials in the occipital, sagittal and parietal regions are composed of 3-6 major spatially independent components of different latencies and wave shapes. The components are of simple shapes: the complexity observed is the result of the presence of various proportions of the components. Simplest over-all responses are obtained from assemblies of dots and of lines, especially radial lines. Some of the components may be individually controlled by changing stimulus conditions without affecting others. The first major peak is inhibited or inverted by modifying the central field stimulation by steady illumination or by a black central area. An unexpectedly strong inhibition occurs with a few steady white lines added to the changing color area stimulus. Total steady field illumination eliminates other components and simplifies the evoked potential shapes. Steps of intensity of illumination within the same color produce little color discrimination. Single dot and line responses are color sensitive with respect to changes in color, and the color of the surrounding field. Defocusing the lines and dots reduces the responses by 70-80%. Exceptionally large responses are obtained to assemblies of dots, illustrating unit and edge sensitivity in the visual system.

Color discrimination is present for area stimulation and is especially marked for changes of color at the same illumination. Spatially independent components characteristic of various colors and color sequences are found, of different latencies.

The use of the evoked potential as a probe for measuring the presence of steady stimuli is described, through some of the non-linear characteristics noted. Visual field interaction causes inhibition as well as addition. The type of field interaction appears different in the peripheral field from the central field and varies with color.

Patterns and component latencies are highly stable for a given stimulus, as averaged over 200 responses, over periods of several years, in adults. The results imply unique spatio-temporal brain patterns characteristic of each perception.

- 190 Clynes, M., & Kohn, M. Recognition of visual stimuli from the electric responses of the brain. In N. Kline & E. Laska (Eds.), Computers and electronic devices in psychiatry. New York: Grune & Statton, 1968.

The evoked potential as measured from the human scalp by our spatial analysis technic is shown to be related to visual experience. Analysis of the spatial and temporal aspects of the evoked potential indicates that it mirrors facets of the code of the brain's physiologic language. Within the limits of our technic, there is a one-to-one correspondence between the spatio-temporal pattern of the evoked potential and the perceptual experience which it accompanies. This parallel extends past the time of conscious perception, suggesting that the aspects of spatio-temporal patterns observed may also be correlated with unconscious processes. It would seem that this approach is of basic importance in the understanding of normal perception and for the future analysis of disease of the brain and mind.

- 191 Clynes, M., Kohn, M., & Gradijan, J. Computer recognition of the brain's visual perception through learning the brain's physiologic language. Institute of Electrical and Electronics Engineers, International Convention Record, 1967, 9, 125-142

There is a 1 : 1 correspondence between color change and visual field structure and the corresponding space-time forms of the brain responses observed in a given individual. For different individuals, the components have the same sequence, and similar timing (time of occurrence has a standard deviation of 3%), but their relative magnitudes vary considerably.

It is possible to find pairs of individuals whose response characteristics are very closely similar. The patterns observed are clearly not the effects of random nerve net learning but represent systemic functional behavior of the brain. The 1 : 1 correspondence and measurement technique is sufficiently precise that a computer can correctly recognize any of about 50 - 100 different visual presentations, as seen by a given individual, from his brain response alone, contained in the four traces recorded.

- 192 Cmiral, J., & Dvorak, J. Zmeny reakce sledovani cile behem 29 hodin prace. [Changes in reaction in target monitoring during 29 hours of work.] Ceskoslovenska Hygiena, 1973, 18, 114-118.

Nine persons were examined in the course of work with predominant mental activity for 29 hours. No circadian periodicity of pulse rate and body temperature was proved. The reactions of target monitoring were analysed in seven persons of the presented group: the fault of monitoring and the changes in the amplitude and phase delay of the monitoring of sinus signal proved to change in a typical and univocal way in the course of the 29 hour work. Working capacity proved to be decreased after 26 hours of work when evaluated by the test used.

- 193 Cohen, J. Very slow brain potentials relating to expectancy: The CNV. In E. Donchin & D. B. Lindsley (Eds.), Average evoked potentials: Methods, results, and evaluations. Washington, DC: US Government Printing Office, 1969.

Walter's original hypothesis that the CNV relates to efficiency of action such as shortening of reaction time because of "cortical priming" is confirmed by the other investigations. McAdam (1969) found that late components of somatosensory AEP between 200 to 400 milliseconds are shorter when the stimulus is presented during the CNV trials compared to presentation during the resting state. Other measures of levels of arousal are consistent with the hypothesis that the CNV is present, representing heightened arousal or alertness, but no change is seen in the early components of the ER.

The work on one very slow potential wave—the CNV—has been reviewed here. We are continuing our work toward understanding the physiological origins and the psychological significance of the CNV as well as exploring its clinical utility (Walter, 1966). We are now exploring a variety of psychiatric and neurological disorders and developmental problems in children. We still conceive of the CNV as the electrical correlate of psychological expectancy and prefer the generality of the term "contingent" since there is such a variety of contingencies which it can represent.

- 194 Cohen, J. The CNV and visual recognition. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 201-204.

The CNV is seen to relate to the accuracy as well as the speed with which threshold information is processed in the brain and is presumed to involve the attentional processes. A larger CNV relates to correct recognition of visual stimuli and to shorter reaction times, but evidence for selective attention is suggested by a somewhat different anterior-posterior gradient of the CNV in the motor response and visual anticipation tasks. The implication is that the CNV is not a unitary process but is modulated by the nature of the informational transactions required by the subject. Its shape and distribution may be a function of the psychological situation in which the subject is set as well as a characteristic of the individual.

- 195 Cohen, J. Cerebral psychophysiology: The contingent negative variation. In R. Thompson & M. Patterson (Eds.), Bioelectric recording techniques (Vol. 1, Part B). New York: Academic Press, 1974.

Normal response parameters in a fairly standard S₁-S₂-R paradigm are well known. The spatial distribution of the CNV and its development in children has been described. The understanding of the CNV as a conditional brain event relating to expectancy makes its study applicable to many clinical psychological and neurophysiological problems which underlie disorders of high-level interaction of brain function such as attention, motivation, perception, and learning. All of the studies relating CNV to performance parameters indicate that it is related to efficiency of function. Impaired functions due to psychopathology or brain disease often are accompanied by deficiencies in the CNV. A brain lesion usually reduces the CNV and ER on the damaged side.

More research is necessary to elucidate the physiological mechanisms, psychological correlates and clinical applications of the slow evoked brain potentials, but the promise of reaching explanatory mechanisms is exciting. It is still less than 10 years since the discovery of the CNV, and the next decade is likely to produce an even greater output of scientific and applied knowledge. We are engaging in research which may also result in making the CNV a standard clinical tool for the neuropsychological investigation of patients for whom the standard EEG has been a disappointing method.

- 106 Cohen, J., & Walter, G. W. The interaction of responses in the brain to semantic stimuli. Psychophysiology, 1966, 2, 187-196.

Long time-constant EEG recording during paired stimuli has led to the discovery of the contingent negative variation or expectancy wave. This effect is produced when a conditional stimulus signals that an imperative stimulus demanding action, decision, or attention will follow at a short, constant time interval. Symbolic and meaningful stimuli were presented to Ss tachistosopically, and the evoked responses in the brain were electronically averaged. The cerebral evoked responses to such psychological stimuli are more complex than to flashes. A slow negative DC potential shift was seen during the interval between an auditory ready signal and the visual exposure if recognition of the stimulus was required, or if it was interesting. Following the visual exposure, a slow positive DC shift occurred. The method was developed to study the brain responses to psychological stimuli. The amplitude of the responses relates to the information content and subjective factors rather than to the physical strength of the stimulus.

- 107 Cohn, R. Differential cerebral processing of noise and verbal stimuli. Science, 1971, 172, 599-601.

Psychophysiological measurements have indicated that the right cerebral hemisphere processes noises and other nonverbal data and that the left cerebral hemisphere processes verbal material. Direct physiological measurements, as expressed in summated auditory evoked cortical responses, unequivocally demonstrate that click noises show a greater amplitude of initial output over the right brain, and that verbal stimuli produce either equal or higher amplitudes of output over the left cerebral hemisphere.

- 108 Coleman, P. D., Gray, F. E., & Watanabe, K. EEG amplitude and reaction time during sleep. Journal of Applied Physiology, 1959, 14, 397-400.

Amplitude of the electroencephalogram was evaluated as a measure of sleep. EEG amplitude during sleep was found to be a) significantly and positively correlated with reaction time, b) inversely related to the duration of periods during which no gross body movement occurred and c) only slightly negatively related to heart rate.

- 109 Coles, M. G. Cardiac and respiratory activity during visual search. Journal of Experimental Psychology, 1972, 96, 371-379.

Recorded measures of cardiac and respiratory activity from 41 male and 3 female undergraduate and graduate students while they performed a series of visual search tasks which varied in target stimulus discriminability. In Exp. I, tonic heart rate was lower and cardiac deceleration greater for low- as compared to high-discriminability tasks. Exp. II replicated the major findings of Exp. I and, in addition, showed that the duration of respiratory period decreased less from an alert to a task level, for low- as opposed to high-discriminability tasks. Results for heart rate are interpreted as supporting J. I. Lacey's intake-rejection hypothesis rather than an effort hypothesis.

- 200 Coles, M. G. Physiological activity and detection: The effects of attentional requirements and the prediction of performance. Biological Psychology, 1974, 2, 113-125.

Cardiac and electromyographic measures were taken from 10 paid, male undergraduate Ss while they performed a total of 1,800 detection trials over 15 sessions. Ss indicated their judgment on a 4-point rating scale as to whether a deflection occurred in a beam of an oscilloscope. On deflection trials, the beam always deflected at the same place, 6 sec after a warning tone. Task difficulty was manipulated by using 3 different deflection durations. Cardiac deceleration was related to task difficulty in accordance with J. I. Lacey's (1959, 1963) intake-rejection hypothesis. Averaged electromyographic activity did not show this relationship, although it showed similar within-task trends to heart rate. Heart-rate level predicted both the accuracy and confidence of the Ss' judgments, and may have reflected fluctuations in the Ss' motivational state. There was an inverted-U relationship between performance measures and heart-rate variability, and this relationship showed some of the changes with task difficulty predicted from the Yerkes-Dodson law.

- 201 Coles, M. G. H., & Duncan-Johnson, C. C. Cardiac activity and information processing: The effects of stimulus significance, and detection and response requirements. Journal of Experimental Psychology: Human Perception and Performance, 1975, 1, 418-428.

In two experiments, measures of heart rate and electromyographic activity were obtained from 40 male undergraduates while they performed two series of trials involving a sequential information processing task. Each trial consisted of a warning light, three successive tones, and a respond light, separated by 6-sec intervals. In Experiment 1, subjects responded only if the three tones were of different frequencies. Accelerative heart-rate responses to the last tone increased as a function of the significance of that tone. Subsequent cardiac decelerations were only observed if the subject was preparing to make a response. These results were replicated in Experiment 2, in which subjects responded only if two of the preceding tones were of the same frequency. Electromyographic activity was not significantly affected by stimulus significance or response anticipation. The data indicate that cardiac acceleration and deceleration reflect two independent psychological processes, associated with information processing and decision-making activity on the one hand, and preparatory activity on the other.

- 202 Coles, M. G., & Gale, A. Physiological reactivity as a predictor of performance in a vigilance task. Psychophysiology, 1971, 8, 594-599.

The experiment was designed to determine the value of measures of physiological activity as predictors of performance in a vigilance task. Subjects, for whom resting (EEG, heart rate, and skin conductance) and response (electrodermal) measures were available, were given an auditory vigilance task. Overall vigilance performance was significantly correlated with one measure of electrodermal habituation, latency of response to the first of a series of stimuli, and total number of responses to stimuli. None of the measures of resting physiological activity were significantly related to vigilance performance. The results are discussed in terms of Mackworth's (1969) theory of vigilance.

- 200 Coles, M. G. H., Porges, S.W., & Duncan-Johnson, C. C. Sex differences in performance and associated cardiac activity during a reaction time task. Physiological Psychology, 1975, 3, 141-143.

Measures of reaction time and cardiac activity were recorded from 10 males and 10 female subjects during a variable foreperiod reaction time task. Males showed faster reaction times, greater cardiac decelerations, and higher levels of heart-rate variability during the foreperiod. Trend analyses revealed sex differences in the heart-rate response to the onset of the warning signal, but not in the response to the imperative signal. These results indicate that those measures of cardiac activity which have been shown previously to predict performance tend to differentiate between the sexes when there are sex differences in performance.

- 204 Coles, M.G., Sossian, B. J., & Isaacson, I. J. Heart rate and skin conductance responses to signal and nonsignal stimuli. Psychonomic Science, 1972, 29, 23-24.

Recorded heart rate and skin conductance from 40 right-handed male undergraduates while they listened to a mixed series of 2 tone stimuli. Ss were required either to count or to give a motor response to 1 stimulus (the signal stimulus) and to ignore the other. Skin conductance responses were larger for signal stimuli than for ignore stimuli, and the motor response Ss gave larger responses than the counting Ss for both types of stimuli. The accelerative component of the heart rate response was greater for signal stimuli. This finding, together with findings from reaction time studies, is discussed in relation to the conceptual distinction between imperative and warning stimuli.

- 205 Colls, J. E. Tests to measure performance changes in mental work (Report No. CEL/HF/19/72). British Steel Corporation, Corporate Engineering Laboratory, May 1972.

Body temperature follows a distinct circadian rhythm - highest in the evening, lowest in the early morning - and various authors have established that performance in simple psychological tests follows a similar rhythm. The aim of this study has been to corroborate this finding in short tests which could be used in the steel industry to predict performance, in place of the more difficult and job specific measures such as production rate and error rate. Three five-minute tests were developed: (a) Cancelling vowels in random letters, (b) cancelling 'e's and 'k's in normal prose, (c) Wilkinson's simple addition. It was discovered that, although there was a correlation between performance and temperature over twenty-four hours, this was due only to the strong night time correlation, and in fact performance fluctuated randomly during the day. In addition, during a continuous twenty-eight-hour experiment, a marked temporary increase in performance level was recorded which coincided with the arrival of dawn. This 'dawn peak' was a psychological phenomenon not reflected in a change in temperature.

206 Colquhoun, W. P. Biological rhythm and shift work. Spectrum, 1967, Dec, 7-8.

A brief account, for the general reader, of the relevance of physiological rhythm research to the problem of organising shift-work in industry. Special reference is made to recent experimental studies at A.P.R.U., in which performance efficiency in various shift systems was found to bear a close relationship to circadian fluctuations in body temperature.

207 Colquhoun, W. P. Circadian variations in mental efficiency. In W. P. Colquhoun (Ed.), Biological rhythms and human performance. London and New York: Academic Press, 1971.

The long-term aim of the research programme that has been outlined would be to identify the fundamental determinants of circadian rhythms in human performance. In this chapter it has been suggested that these rhythms are related to fluctuations in the "state of arousal" of the organism. The physiological concomitants of the arousal state may well prove to be extremely complex, and no one measured variable may be found adequate for reflecting variations in it with sufficient consistency. Thus, as we have seen, the earlier view that body temperature might serve this purpose has been called into question by some of the more recent findings (e.g. on the post-lunch phenomenon, and the differential rates at which performance and temperature rhythms alter in response to a changed sleep-waking routine). Nevertheless it remains true that a direct test of the dependence of mental efficiency on the body-temperature rhythm has never been made. In an appropriately equipped laboratory it would be possible to make such a test by deliberately interfering with the normal temperature cycle (perhaps through the medium of anti-pyretic drugs) in order to alter its characteristics. This kind of manipulative technique could be extended to hormonal and other factors exhibiting circadian periodicity, this periodicity being either eliminated or altered systematically during the course of a regular series of performance-testing observations in order to determine the existence of any dependency between physiological and psychological parameters in each case.

- 208 Colquhoun, W. P., Blake, M. J. F., & Edwards, R. S. Experimental studies of shift-work III: Stabilized 12-hour shift systems. Ergonomics, 1969, 12, 865-882.

Twenty-two subjects took part in an experiment to determine whether the relationship between efficiency at mental tasks and the circadian rhythm of body temperature observed in two earlier studies was affected by an increase in the length of the duty spell from 8 to 12 hours. Subjects were assigned either to a control 'day' shift (0800-2000) or a 'night' shift (2000-0800), and were tested for a period of 12 consecutive days on the same shift. Some signs of fatigue due to the excessive length of the duty-spell were observed, but an underlying relationship between temperature and performance remained in evidence in some scores throughout the trial period. Adaptation of temperature rhythm to work on the night shift was only partial, and less marked than in a previously studied 'night' work situation; the partial adaptation was nevertheless relatively closely reflected in the recorded performance trends. It was concluded that the results obtained in the present and previous studies in this series demonstrated that, within certain limits, the relationship between temperature and efficiency was sufficiently marked to warrant further research into its generality.

- 209 Connor, W. H., & Lang, P. J. Cortical slow-wave and cardiac rate responses in stimulus orientation and reaction time conditions. Journal of Experimental Psychology, 1969, 82, 310-320.

Studied the cortical slow wave and cardiac rate of 24 male undergraduates in response to simple nonsignal auditory tones and to similar tones marking the onset of an RT foreperiod. Cortical negativity and the amplitude of the biphasic heart rate response were greatest under high-intensity and signal conditions. The initial acceleratory and secondary deceleratory components showed a positive correlation with cortical negativity. Ss who reported themselves to be more alert during the task yielded higher negativity. Slow-wave activity also covaried with eyeball movement, although eyeball movement did not predict the cortical response. The slow-wave response of the brain varies systematically with cardiac rate events which have been theoretically associated with attentional processes and activation.

- 210 Cook, J. J. Additional variables in autonomic measurement. Psychophysiology Newsletter, 1963, 9, 14-22.

In general, the results support the findings of two previous experiments (Cook and Gendlin, 1961; Gendlin and Berlin, 1961) when physiological activity accompanying continuous focusing on feelings was compared with the activity associated with a state characterized by discontinuous external reference. That is, indices of reduced tension, lower GSR rate, greater decrement in skin resistance, and wider range in both skin resistance and heart rate accompanied the "focusing-on-feeling" state. In addition, the present study also found that a greater rate of increase in finger temperature was present. Thus, it is possible to conclude that the contents of instructions, insofar as they call upon the subject to focus his attention internally as opposed to externally, can have a differential effect on the autonomic activity accompanying the activity called for by instructions.

- 211** Corah, N. L. Some perceptual correlates of individual differences in arousal. Journal of Personality, 1962, 30, 471-484.

The studies were designed to explore a hypothesized curvilinear relationship between individual differences in arousal and perception in a relatively normal population. Palmar conductance served as the indicant of arousal level.

The first study explored this relationship with kinesthetic figural after-effects, figure reversals, and disjunctive reaction time as the perceptual measures. It was predicted, on the basis of Kohler's theorizing about attentional perception, that Ss in the middle of the arousal continuum would give larger after-effects, more figure reversals, and shorter reaction times than would Ss with either high or low arousal scores. These hypotheses were tested with 46 men.

The predictions were generally confirmed when the palmar conductance measures associated with a given task were used for the analysis of that performance measure. Subsequent analysis with Ss' mean conductance scores for the entire session were not significant. The interrelationships of the performance measures were also not significant. These results were discussed in relation to studies of personality and perception, and to working assumptions about chronic drive states in normal populations.

The second study was designed to test the hypothesized curvilinear relationship in reference to consistent individual differences in level of arousal. Ss were preselected on the basis of their palmar conductance scores. Seventy-two men and women representing the extremes and middle of the arousal continuum were tested on the kinesthetic after-effect task. The results were not significant, although the after-effect scores for the men were in the predicted direction. Possible implications of this work for further investigation were discussed.

- 212** Corby, J. C., & Kopell, B. S. The effect of predictability on evoked response enhancement in intramodal selective attention. Psychophysiology, 1973, 10, 335-346.

Investigated the relationship between the attention enhancement of the visual average evoked response (AER) and S's ability to predict the presentation of the attended stimulus. Twelve undergraduates were presented with sequences of 2 distinct visual stimuli while EEG and electrooculogram were simultaneously recorded. Stimuli were either regularly alternated (predictable) or randomly intermixed (nonpredictable). Verbal instructions directed S's attention and push button response to either 1 or both of the 2 stimuli. Interstimulus interval was held constant to permit computer averaging of AER and contingent negative variation. Selective attention enhanced the late positive component of the AER equally in the 2 conditions of predictability. Thus, it seems that the AER enhancement with intramodal selective attention does not depend on S's ability to predict the presentation of the attended stimulus or to differential arousal prior to its presentation. In the high predictability condition, baseline EEG potential fluctuated with attention such that the AERs to the attended stimuli were negative relative to those to the ignored stimuli.

- 213** Corcoran, D. W. J. Changes in heart rate and performance as a result of loss of sleep. British Journal of Psychology, 1964, 55, 307-314.

Two theories of the effects of loss of sleep were compared against existing facts. The hypothesis that sleep deprivation reduces arousal was judged to be more adequate than the theory that arousal is increased by loss of sleep, the former failing only to account for raised physiological indices of arousal in some experiments. These are attributed to experimental conditions which compel the subject to make compensatory efforts to maintain adequate levels of performance. Under such conditions effort, not arousal, is reflected in the indices.

An experiment was conducted in which a constant high level of performance was not demanded of the subjects over a 60 hr period without sleep. Heart rate and performance fell with loss of sleep.

- 214** Corlett, E. N. Cardiac arrhythmia as a field technique: Some comments on a recent symposium. Ergonomics, 1973, 16, 3-4.

The seminar on 'Heart Rate Variability and Mental Load' at which the papers in this issue were presented was attended mainly by research workers and presented by researchers. The examples given and problem areas posed in these papers are either actual field studies or analogues of field situations. It is not unreasonable therefore to look at the work reported in relation to its contribution to the study of mental work and mental load, not in any carping spirit but to indicate the enormity of the task facing the field worker who is studying mental work. This approach will also indicate the quality of personnel which will be needed in industry if this area is to be adequately treated. To say the least, it seems unlikely that industry will be able to continue with the use of simple techniques and technician level personnel for the study of work loads arising from modern industrial jobs. The seminar gave a clear indication that the study of working stress requires a professional level of training, i.e. one equivalent at least to a Chartered Engineer in quality, if the effective interpretation of data, which are in themselves reliable, is to be achieved.

This seminar was a step, a recognised point, on the journey towards the elucidation of measures of mental load. It is a point for assessment of progress and perhaps coordinating future directions. If the standardisation of symbols, of terminology, even of recording methods and test conditions, is attempted, this could aid in the comparison of results between workers and encourage the readier use of what is currently available to measure environmental and work stresses in terms meaningful for ergonomics.

- 216 Corletto, F., Gentilomo, A., Rosadini, A., Rossi, G. F., & Zattoni, J. Visual evoked responses during sleep in man. Electroencephalography and Clinical Neurophysiology, 1967, Supplement, 26, 61-69.

A study of the averaged electroencephalographic response to single photic stimuli during wakefulness and nocturnal sleep has been made in fourteen adult subjects.

In all subjects the amplitude of the evoked potential considered as a whole reaches its maximum during sleep with EEG synchronization and its minimum during sleep with desynchronized activity and rapid eye movements.

The amplitudes of the single components of the evoked potential, and the "morphology" of the potential itself, show different behaviors during wakefulness and the four phases of sleep. The events observed are not uniform in the different subjects examined: three main patterns have been identified.

- 216 Corteen, R. S. Basal conductance level and motor performance. British Journal of Psychology, 1967, 58, 93-100.

Investigated the relations between logarithm basal conductance and performance on 3 tasks with 27 students. Significant relations were found with end spurt and reminiscence on the pursuit rotor, with overall performance on a dotting task, and with abnormally slow responses and optimum response speed in RT. Results are consistent with a view of basal conductance as a measure of tonic activation.

- 217 Corteen, R. S., & Blackman, A. R. Skin conductance change and sensory discrimination. British Journal of Psychology, 1965, 56, 431-437.

The relation between mean log change in conductance and sensory discrimination was investigated. Highly significant relations were found with critical flicker frequency (CFF) and 2-point tactile thresholds. No significant relation was found with discrimination of a pure tone from background white noise. An attempt at explanation is offered in terms of a cortically controlled center mediating a sensitizing or orienting response of which conductance change is a peripheral manifestation.

- 218 Costello, C. G., & Hall, M. Heart rates during performance of a mental task under noise conditions. Psychonomic Science, 1967, 8, 405-406.

Gibson and Hall reported that performance of mental tasks under noise conditions resulted in significantly greater heart rate acceleration than performance under no-noise conditions. Three experiments are reported. One is a replication of the Gibson and Hall experiment with essentially the same results. Exp. II showed that noise alone did not result in heart rate acceleration. Exp. III found that extreme scorers on a scale of anxiety did not show heart rate acceleration under the Gibson and Hall conditions.

- 219 Coules, J., & Avery, D. L. Human performance and basal skin conductance in a vigilance-type task with and without knowledge of results. Perceptual & Motor Skills, 1966, 22, 1295-1302.

No trends were shown between reaction time (RT) and intersimulus intervals and RT and time blocks under knowledge of results (KORs) or no knowledge of results (NKORs). An ABC X S variance design of RT scores showed only KORs by Ss was statistically reliable. The source of this variance was attributed to sex differences. Results showed that under KORs fast mean RT (males) was associated with high skin conductance. For females slow mean RT was associated with low conductance. Under the NKORs condition, females showed slower mean RT than males. Their conductance scores showed significantly greater variability without knowledge of results than under the knowledge condition. Males under no knowledge show mean conductance scores as high as those under knowledge of results. However, their mean RT scores under the NKORs condition was significantly lower than under KORs. It was concluded that males, contrasted with females, respond differentially to KORs and NKORs in simple RT studies. As males show high conductance and females high variability in conductance under NKORs, an inhibition-reinforcement theory for vigilance tasks appears inadequate.

- 220 Cowles, M. P. The latency of the skin resistance response and reaction time. Psychophysiology, 1973, 10, 177-183.

Skin conductance level (SCL) and skin resistance response (SRR) latency to a foreperiod warning light were shown to be related to a measure of simple reaction time performance. Other physiological measures monitored immediately prior to the task were not related to performance nor were they interrelated. Speculation is offered on the possible mechanism whereby a central facilitation system is related to SRR latency and to performance.

- 221 Cox, J. J. Train control, stress and vigilance. Proceedings of the 10th Annual Conference of the Ergonomics Society of Australia and New Zealand, 1973, 16.1-16.22.

Modern railway operation, due to the control exerted on the man-machine-pathway combination is the safest form of transportation available. The vehicle pathway is continuously monitored and both front and rear end protection is provided to prevent collisions. Man although extremely versatile is known to be the weak link in the man-machine system. Consequently, his duties need to be arranged to match his capabilities. An examination is made of human factors research, levels of arousal, driving efficiency and driver stress, fatigue, diurnal body rhythm and vigilance. Accident rates have been progressively reduced by various safeguards instituted to guard against human failure. Measurements of driver stress under various conditions of high speed train operation have been carried out and changes in stress in accordance with train speed, hours of duty, periods of rest, and day and night operation determined. There are a series of railway signalling and vigilance control devices which successively reduce the effect of the human element. These have further developed into semi-automatic and automatic train operation.

- 222** Craig, A., & Colquhoun, W. Vigilance: A review. In C. G. Drury & J. G. Fox (Eds.), Human reliability in quality control. London: Taylor and Francis, 1975.

This account of vigilance research has shown that several factors, each of theoretical relevance, are important in determining inspection efficiency. These include environmental conditions, such as the ambient temperature, or whether the task is being performed during the day or at night; personality variables, of which the most important, so far, seems to be extraversion-introversion; task related factors such as the probability that an item will be defective and the spatial location of the fault itself; and, finally, the decision-making processes of the observer.

No unique theory has emerged which would explain the role played by each of these factors in contributing to the two main problems of vigilance: first, the low overall level of performance, and secondly, the fall-off in efficiency over time. The most acceptable ideas would seem to be that the vigilance phenomena are due to the observer's expectancy for signals, on the one hand, or to his physiological state on the other, and it was indicated that these two factors could operate independently or in conjunction to account for most of the findings.

- 223** Creutzfeldt, O., Grunewald, G., Simonova, O., & Schmitz, H. Changes of the basic rhythms of the EEG during the performance of mental and visuomotor tasks. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

No clear correlation between occipital alpha rate and the different tasks could be found in our experiments, although they could be scaled satisfactorily by subjects according to the degree of 'psychical effort' needed for their performance, and in contrast to the heart rate changes, which showed a high correlation to the subjective scaling. If we assume that this 'effort' is at least a rough measure of 'attention' or 'concentration', we may conclude that no simple correlation exists between the amount of attention or concentration and the degree of the alpha reaction within the range of our experimental situation. This is in agreement with the observations of Kreitman and Shaw. On the other hand, it may be noted, that occipital alpha was always reduced at the time the subject read the instructions. This may be related to the visual-oculomotor activity as well as to a different form of 'concentration' involved in reading.

The reaction of the central rhythmical activity (μ -rhythm) was different in our experiments in so far as a significant reduction was observed during all tasks and in all persons. Even though motor activities were not always excluded in the different experiments, the amount of motor activity varied considerably and was not related to the 'difficulty' of the tasks. It thus appears that the μ -rhythm seems to react more sensitively to 'problem solving activities' of the brain than does the occipital alpha. This does not exclude a higher responsiveness to more localized activities in the somato-sensory and motor system, but needs a critical interpretation of such findings as to their physiological relevance.

- 224 Crider, A. Electodermal lability and vigilance performance. Psychophysiology, 1972, 9, 268. (Abstract)

The hypothesis was tested that individual differences in the speed of habituation of the electrodermal OR would predict detection adequacy in a vigilance task requiring sustained attention on a stimulus display. Habituation of the skin potential response to serially presented tones was measured on 2 separate occasions in a group of 50 male Ss. Extreme groups of "labiles" and "stabiles" were selected in terms of consistently slow or fast habituation in both sessions. Twelve members of each group were subsequently run in an auditory vigilance task requiring detection of infrequent digit combinations against a background of 1 sec random digits. Over the 48-min vigil, labiles showed a relatively high and sustained level of performance while stabiles showed an initial deficit which increased with time on task. No differences were found in commission errors. Labiles had a higher frequency of skin potential responses during the task, but no group differences were found in skin potential level.

- 225 Crider, A., & Augenbraun, C. B. Auditory vigilance correlates of electrodermal response habituation speed. Psychophysiology, 1975, 12, 36-40.

The present study was designed to test the hypothesis that individual differences in the speed of habituation of the phasic electrodermal response (EDR) reflect characteristic rates of attentional decrement with stimulus repetition. Subjects selected for the extremes of EDR habituation speed to a pure tone were subsequently tested in an auditory vigilance task. Slow habituators showed a high and sustained rate of signal detection, while fast habituators showed a lower overall rate and a time-on-task decrement. Further analyses employing signal detection theory measures indicated that these detection differences were due to group differences in response criterion levels rather than to differences in the rate of attentional decrement. The implications of this finding for understanding individual differences in EDR habituation speed are discussed.

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- 226** Dahl, H., & Spence, D. P. Mean heart rate predicted by task demand characteristics. Psychophysiology, 1970, 7, 369-376.

Predicted mean heart rates (HRs) recorded during sequences of perceptual-motor and cognitive tasks from ratings of task characteristics, e.g., complexity and frequency of stimuli, transformations, and responses. In 3 separate groups of Ss (22 18-35 yr. old men and women, 19 undergraduates, and 20 Royal Canadian Air Force trainees) and tasks, the correlations between mean HRs and task demand ratings were $\geq .91$.

- 227** Danev, S. G. Heart rate and performance at various types of information coding under laboratory conditions. Activitas Nervosa Superior, 1968, 10, 15-21.

Compared heart rate, number of errors on the basic task, number of errors and performance on the secondary task, and the subjective estimate of difficulty of various tasks for 9 female and male undergraduates. The total amount of information per sec was equal, but individual tasks differed in the signal-response relationship (direct correspondence, mirror image in Exp. I) or in the manner of information presentation (chunk of information input through 1 or 2 sensory channels, one or two parallel responses and codes in Exp. II). Significant differences were found in both experiments. Both the heart rate and performance level were influenced by various aspects of information coding and the total amount of information presented per time unit.

- 228** Danev, S. G. A study of some factors influencing pulse frequency in conditions of paced choice-reaction performance. Activitas Nervosa Superior, 1968, 10, 389-394.

Studied the effect of difficulty of information processing on pulse frequency, RT, and number of errors in 3 experiments. In Exp. I the phase of stimulus identification was complicated and the phase of response selection was simple, the phases in Exp. I were reversed in Exp. II, and in Exp. III both series were simple. Results show that the systematic increase of information flow is connected with an increase of studied characteristics only in Exp. I and II. Relationships between factors like "time stress," level of training, level of vigilance, emotional tension, and measured characteristics are summarized in a diagram.

- 220 Danev, S. G., & de Winter, C. R. Expectation, attention and heart rate deceleration; some complications in the use of heart rate variability for assessing mental loads. Leiden, the Netherlands: Netherlands Institute of Preventive Medicine, TNO, 1970.

In a choice reaction task in which the stimulus was preceded by a stationary warning signal, the influence of active attention upon the temporary changes in the level of heart rate was shown. The heart rate decelerated just before the stimulus was presented. This effect was stronger prior to stimuli with great informational content than before stimuli with smaller informational content. In a second experiment, a serial eight-choice reaction task was performed. Here it was shown that after mistakes there was a short-term deceleration of the heart rate level, while after correct responses an accelerating tendency was found. Attention and committing errors have to be regarded as additional causes of fluctuations of the level of heart rate. Therefore, they have to be taken into account when suppression of sinus arrhythmia is used for assessing the level of mental load.

- 230 Danev, S. G., & de Winter, C. R. Heart rate deceleration after erroneous responses. Psychologische Forschung, 1971, 35, 27-34.

In an eight-choice reaction task, the influence of erroneous responses upon the temporary changes in the level of heart rate (HR) was studied. It was shown that after errors there was a short-term deceleration of the HR-level, while after correct responses an accelerating tendency was found. This phenomenon has to be regarded as an additional source of fluctuations of the HR-level. Therefore, it has to be taken into account when suppression of sinus arrhythmia is used for assessing the level of mental load.

- 231 Danev, S. G., de Winter, C. R., & Wartna, C. F. Information processing and psychophysiological functions in a task with and without time stress. Activitas Nervosa Superior, 1972, 14, 8-12.

Conducted an experiment in which 6 Ss added a series of 2 3-digit numbers (Group 1 without time limits, Group 2 within time limits which were experienced as "time stress"). Ss showed a nonsignificantly better performance in Group 1 (more additions per unit of time and less peripheral vasoconstriction); and a higher level of heart rate, and larger number of errors, misses, and "mental blocks" in Group 2. It is concluded that it is not acceptable to use the changes of the mentioned psychophysiological parameters for assessment of the so-called "information load."

- 232 Danev, S. G., Wartna, G. F., Bink, B., Radder, J. J., & Luteyn, I. Psychophysiological assessment of information load. Nederlands Tijdschrift voor de Psychologie en haar Grensgebieden, 1971, 26, 23-39.

Assessed the different demands imposed on individuals by a sensorimotor task under 2 levels of information load. The measured psychophysical parameters were heart and respiratory rates and their variability. The performance was measured in terms of RT, misses and mistakes and performance on a secondary task. Six male students responded to 2 conditions: punching the correct button when either of 2 lights appeared and, similarly, when 8 lights appeared. The secondary task was a simple addition problem to be solved before the button was pressed. Analysis of variance indicated that RTs, mistakes and misses and performance on the secondary task discriminated best between the 2 conditions. Different Ss reacted differently to the 2 conditions in their cardiac and respiratory functioning. The relation between RT and various phases of the cardiac and respiratory cycle and the length of time the button was pressed in response to signals was significantly related to the information load.

- 233 Daniel, R. S. Electroencephalographic pattern quantification and the arousal continuum. Psychophysiology, 1966, 2, 146-160.

The view that the EEG shows a continuum correlated with behavioral arousal was subjected to experimental test. A simple model of the expected results from five experimental states of arousal was used as a criterion against which to evaluate various parameters of EEG data after they had been processed by electronic analysis systems.

Eighteen normal young adults were the Ss. Occipital and parietal recordings were taken during relaxation, attention, arousal, recovery, and relief states. Sample epochs of the records were analyzed by amplitude distribution, frequency spectrum, power spectrum, wavelength distribution, autocorrelation, and cross correlation.

No single parameter matched the predicted model in a convincing manner. However, correlograms of occipital recordings after interpretation by relative power ratios did support the hypothesis with statistically significant differences. It was concluded that behavioral arousal is inversely related to the scaled continua of (1) the proportion of total power to be found at the dominant frequency, and (2) rhythmicity of the dominant wave.

- 234 Daniel, R. S. Alpha and theta EEG in vigilance. Perceptual and Motor Skills, 1967, 25, 697-703.

During a 1-hour vigilance session Ss were required to detect specified digit triads in an uninterrupted random digit series. EEG was recorded continuously with sampled epochs analyzed by computer for autocorrelation and period analysis. Correlogram ratios indicated progressively decreasing arousal through the session but did not distinguish responses from detection failures. Incidence of alpha waves by period analysis also did not identify errors, but incidence of theta waves dropped significantly just prior to failures and did not do so around responses.

- 235 Dardano, J. F. The relationships of intermittent noise, inter-signal interval, and basal skin conductance to vigilance behavior (Doctoral dissertation, University of Maryland, 1959). Dissertation Abstracts, 1960, 20, 4182. (University Microfilms No. 60-1278)

Conductance trends for all Ss except one demonstrated a systematic trend during the vigil. Conductance was negatively correlated with the logarithm of reaction time for seven of 12 Ss monitoring the wide dispersion schedule, for five of 12 Ss under the intermediate dispersion schedule, and for one S under the narrow dispersion schedule. In the group monitoring the wide dispersion schedule, which required continuous attention, the five Ss without a significant correlation demonstrated better overall performance and less deterioration relative to the seven Ss with a significant correlation. The conductance trends of these five superior Ss demonstrated an immediate increase at the start of the session and a higher than initial level for a minimum of 1 hr.

Research in the area of vigilance and theoretical frameworks to explain the findings are reviewed.

- 236** Dardano, J. F. Relationships of intermittent noise, intersignal interval, and skin conductance to vigilance behavior. Journal of Applied Psychology, 1962, 46, 106-114.

Army enlisted men individually monitored a CRT screen for 3 hrs in isolation. One of 3 signal schedules differing in degree of intersignal interval (ISI) variability was paired with presence or absence of intermittent noise to provide 6 monitoring conditions. Six Ss performed under each condition. Reaction time to signals and skin conductance were recorded during the vigil. Results indicated that: (a) noise impaired performance when the schedule with minimum ISI was monitored, (b) detection time was inversely related to length of ISI for schedules with minimum and intermediate degrees of ISI variability, (c) conductance was negatively correlated with reaction time for Ss exhibiting an extreme decrement under the schedule with maximum degree of ISI variability.

- 237** Dardano, J. F., & Mower, I. Relationships of intermittent noise, inter-signal interval and skin conductance to vigilance behavior (Technical Memorandum 7-59). Aberdeen Proving Ground, Md.: Human Engineering Laboratories, July 1959.

Monitoring performance did not deteriorate with low variability of inter-signal intervals, 50-70 sec. Intermittent noise impaired performance with this schedule by slightly increasing reaction times during the entire session. With a greater variability of inter-signal intervals, performance deteriorated continuously during the vigil and was unaffected by intermittent noise.

A minimum inter-stimulus interval of 30 sec resulted in an inverse relationship between reaction time and length of inter-stimulus interval, at least up to the mean interval.

Basal skin conductance was negatively correlated with logarithm of reaction time when performance deteriorated under a signal schedule requiring continuous observation.

- 238** Dargent, J., & Dongier, M. (Eds.). Variations contingentes negatives. [Contingent negative variation.] Liege: University of Liege, 1969.

Presents a revised and augmented transcript of a colloquium held at the University of Liege under the direction of W. Grey Walter. Among the topics discussed are: Technical Aspects; Psychophysiological Aspects within Man; Psychophysiological Aspects within Animals; and Applications to Pathology. The section dealing with studies of the human CNV covers, among other topics: Interindividual Variations; Experimental Paradigms (Reaction time, Degrees of Motivation, Voluntary Participation, Decision Making, etc.); Variations in the Probability of Stimulus Associations; Distraction; Concentration of Attention; Preparation for Motor Activity; Muscular Effort Required for Responses; the Wave of Intention; Motivation; Fatigue; Complex Tasks; Variations in Vigilance or Attention; and Reaction Time.

- 239 Darrow, C. W., Vieth, R. N., & Wilson, J. Electroencephalographic "blocking" and "adaptation". Science, 1957, 126, 74-75.

Phase relationships of waves in different head areas had previously shown reliable adaptation of response to successive gong stimuli, and the palmar galvanic responses were likewise reliably reduced with repetition. We have also found that, with eyes closed, repeated writing of a word on an imaginary blackboard produces marked initial blocking, especially in the left hemisphere, and a decrease or elimination of blocking with practice. In fact, any novel stimulus or activity will tend, at first, to be accompanied by blocking of the alpha rhythm, and, with familiarity, habituation, solution of the problem, or rendering of the activity automatic, alpha will be restored.

- 240 Davies, D. R. Physiological correlates of sleep deprivation and performance in unstimulating conditions. Bulletin of the British Psychological Society, 1968, 21, 135. (Abstract)

Three areas of research were reviewed dealing with (i) the recording of physiological measures during the performance of unstimulating tasks by sleep deprived and other subjects; (ii) individual differences in the effect of 'arousal' variables upon performance and (iii) individual differences in sleep patterns both under normal laboratory conditions and after sleep deprivation. The possible interrelations of these areas was discussed and speculations offered concerning (a) possible differences, in their effect upon performance, between REM and NREM sleep deprivation, and (b) possible interactions between sleep profiles and the effects of sleep deprivation.

- 241 Davies, D. R., & Krkovic, A. Skin-conductance, alpha-activity, and vigilance. American Journal of Psychology, 1965, 78, 304-306.

In the typical vigilance-situation, S is required to detect and to respond to slight and infrequent changes in stimulation over long periods of time. The usual finding has been that performance declines markedly after a half-hour at the task. Little attention has thus far been paid to the possibility of a relationship between performance in vigilance-tasks and electrophysiological measures of activation, such as skin-conductance and EEG alpha-activity. The present experiment was designed to investigate such a possibility.

- 242 Davies, D. R., & Parasuraman, R. Cortical evoked potentials and vigilance: A decision theory analysis. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

Studies of the psychophysiological concomitants of vigilance performance are briefly reviewed. It is suggested that performance assessment has been inadequate or incomplete in the majority of these studies and that it would be profitable to utilize measures derived from statistical decision theory, particularly in relation to indices of cortical activity, in studies of vigilance. The evoked potential (EP) is then described and research relating late EP components to decision processes is outlined. The few experiments that have examined EPs in relation to vigilance performance are examined and suggestions for further research are made. These are implemented in two experiments on vigilance, the first concerned with the effects of event rate and signal regularity on measures of EP amplitude and of vigilance performance and the second with response latencies in vigilance and their associated EP component latencies. It is concluded that both late amplitude and latency measures of the EP are significantly related to (1) within session performance changes, (2) differences in response latency associated with different response categories, and (3) the effects of independent variables such as event rate and signal regularity. In the last part of the paper a model is outlined in which both speed and accuracy measures of vigilance performance can be incorporated within a decision theory framework, and some preliminary results suggesting that EP late components provide correlates of decision processes in vigilance are discussed.

243 Davies, D. R., & Tune, G. S. Human vigilance performance. New York: Elsevier, 1969.

Reviews empirical and theoretical literature pertaining to human vigilance. Psychophysiological correlates of vigilance are discussed in a number of different sections of the book. Topics covered include:

1. Definitions of vigilance and measures of performance.
2. The background to studies of vigilance performance.
3. Signal characteristics.
4. Task variables.
5. Subject variables.
6. Environmental variables.
7. Theories of vigilance.

244 Davis, H. Enhancement of evoked cortical potentials in humans related to a task requiring a decision. Science, 1964, 145, 182-183.

The averaged, slow response evoked by auditory stimuli and recorded from the vertex of the human skull can usually be enhanced by requiring the listener to make a rather difficult auditory discrimination. An easy routine reaction is not effective.

245 Davis, H., Mast, T., Yoshie, N., & Zerlin, S. The slow response of the human cortex to auditory stimuli: Recovery process. Electroencephalography and Clinical Neurophysiology, 1966, 21, 105-113.

The late, slow, non-specific diffuse cortical response (the "V potential"), recorded from the vertex relative to mastoid or ear, has been studied by the method of averaged responses in waking young adults.

The amplitude of the V potential is best measured from peak of N_1 to trough of P_2 . The amplitude increases slowly with the intensity of the pips.

For maximal amplitude the intervals between stimuli must be over 6 sec and probably at least 10 sec. If the intervals are regular the average amplitude is about 1/2 maximal at 3 sec, 1/4 at 1 sec and 1/6 at 0.5 sec. If pairs of tone pips are employed the amplitude of the second response depends on the long interval between pairs as well as on the short interval between the members of the pair. Variability is considerable from test to test and across subjects but statistically the recovery function is smooth and reproducible.

- 246** Davis, R. C. The stimulus trace in effectors and its relation to judgment responses. Journal of Experimental Psychology, 1952, 44, 377-390.

The temporal course of the excitation is somewhat like that usually attributed to the stimulus trace. It varies with the following factors: (a) simple vs. choice response; (b) regularity vs. irregularity of time interval between stimuli of a pair; and (c) duration of the first stimulus of a pair.

It is, therefore, less closely bound to the stimulus than the stimulus trace is sometimes supposed to be, but varies with the "setting factors" as well. This variation could be accomplished by a feedback in the system.

The proportion of judgments of "stronger" and "weaker" bears no discernible relation to its total amount of activity in the two arms prior to the judgment.

It is related, however, in a variety of circumstances, to the difference in prior activity of the arms designated to give "stronger" and "weaker" judgments, the more active arms giving the greater number of responses.

It is proposed that the action potentials from the two arms represent the activity state of two competing response systems; that both are excited by the first stimulus but have differing response curves and initial levels; that, other things being equal, the system which has advantage at the time of the second stimulus will further build up its activity until enough force is generated to close a key.

- 247** Day, M. E. An eye movement phenomenon relating to attention, thought and anxiety. Perceptual & Motor Skills, 1964, 19, 443-446.

An eye movement phenomenon, which is thought to be related to the shifting of attention and personal ways of handling anxiety, is described and discussed in relation to certain research hypotheses.

- 248** Debecker, J., & Desmedt, J. E. Rate of intermodality switching disclosed by sensory evoked potentials averaged during signal detection tasks. Journal of Physiology, 1966, 185, 52-53.

The subject was instructed to recognize either clicks or finger shocks of barely noticeable smaller intensity, substituted at random for about 10% of the standard stimuli in a series. When the period of the alternating bimodality series of stimuli is reduced to 1.2 sec, the late surface-positive component increases for the evoked potentials corresponding to the modality involved by the decision task. The lack of change in the 'primary' early component of the somatosensory evoked potentials confirms that the afferent volley is not influenced on its way to the cortex under the conditions of these experiments (Desmedt et al. 1965). In several subjects the reciprocal correlation shown for the late components is still observed for periods of 1.0 or sometimes even 0.8 sec. It disappears for periods of 0.6 sec. These rather high rates of intermodality switching suggest that phasic mechanisms control the intra-cortical processing of corticopetal volleys.

- 249** Debecker, J., & Desmedt, J. E. Cerebral evoked potential correlates in forced-paced tasks. Nature, New Biology, 1971, 234, 118-120.

Examined "the evoked potential correlates of sensory overload in forced-paced auditory tasks and ... [found] that the cerebral 'decision' potential can reveal intermittency in the perceptual channel. Fifteen young adult volunteers with normal hearing served in 1 or more sessions. Each sat in an easy chair in a soundproof air-conditioned room. Binaural clicks were delivered...at a regular interval which is the same throughout any run, chosen from 1,000-200 [msec] for successive runs. Each such run included a random sequence of 50% signal clicks (80 db above subjective threshold) and 50% non-signal clicks of lower intensity...The S was asked to count mentally the signal clicks in the sequence, to avoid key-pressing or vocalizing which might induce so-called readiness or motor potentials. The cerebral potentials evoked by the signal clicks were recorded between vertex (Cz) and mid-frontal skin electrodes." Seventy-five runs (frequencies, 1-5/sec) were carried out in 16 sessions in 14 Ss. The "results disclose rapid dynamics for the evoked potential 'decision' components and indicate that rapid sequential tasks represent a cognitive load adequate to trigger this mechanism." It is felt that further studies in this area "may provide an approach to the neural switching processes which organize information."

- 250** Debijadji, R., Perovic, L., Nagulic, S., & Djurakic, D. Reactions psychophysiques des pilotes des avions supersoniques en vol. [Psychophysiological reactions of pilots of supersonic aircraft in flight.] Revue de Medecine Aeronautique et Spatiale, 1973, 12, 367-371.

SST pilots were subjected to in-flight tests: electrocardiogram, cardiac frequency, urine catecholamine excretion. The subjects were separated into two groups: one was comprised of pilots with little experience and the other of pilots with much flight experience. Their flight program was highly complex. Good correlation was found between cardiac frequency and intensity of the sympatho-adrenal reaction on the one part and piloting experience and flight program on the other.

- 251** Deecke, L., Becker, W., Grozinger, B., Scheid, P., & Kornhuber, H. Human brain potentials preceding voluntary limb movements. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 87-94.

The Bereitschaftspotential (BP), also called the readiness potential (RP), was found in 1964, when we first used our technique of averaging tape-stored EEG data in the reverse time course and thus were able to average signals that are time-locked to unpredictable events. Similar to the expectancy wave or CNV (Walter 1964), the BP is a negative, slow brain potential which starts sometimes as early as 1.5 sec before movement. The onset is very much dependent on the experimental situation. The BP has, in common with the CNV, the susceptibility to psychological influences, so that it increases with increasing level of motivation and decreases, or could be almost abolished, with subject inattentiveness, carelessness or lack of concern. In our experiments the subjects were trained to achieve complete electromyographic silence in the muscle from which we were recording with needle electrodes. They were then asked to perform repeatedly a very fast and stereotyped movement, which was observed both myographically and mechanographically. Thus, the movements became skilled, and greatly increased the BP, especially when good performance was rewarded. The very first EMG activity in the depth of the effector muscle was used to trigger the average computer. This yielded exact time-locked epochs, without which the two other potentials, to be discussed later, could not be properly recorded.

- 252** Deecke, L., Scheid, P., & Kornhuber, H. H. Distribution of readiness potential, pre-motion positivity, and motor potential of the human cerebral cortex preceding voluntary finger movements. Experimental Brain Research, 1969, 7, 158-168.

The results show that there are three different potentials preceding voluntary movement which can be recorded from the human scalp: (1) the readiness potential (RP), (2) the motor potential (MP), and (3) the pre-motion positivity (PMP).

1. The surface negative RP occurs bilaterally symmetrical over the pre- and post-central region. It has its maximum at the vertex. It is positive at frontal and basal leads. The positivity is not due to a negativity at the reference electrode because it occurs also with a sternum-vertebra prominens reference, and the mastoid reference shows a positive rather than a negative potential. It cannot be excluded that the frontal and basal positivity is due at least in part to a sink with a source in the pre- and post-central region. The amplitude of the RP is nearly bilaterally symmetrical in the pre- and post-central region. Bipolar recordings, however, show that in some subjects it may be larger over the contralateral than ipsilateral precentral hand region in the last 300 msec before onset of movement.

2. Contrary to the RP, the MP shows its maximum not at the vertex but over the contralateral precentral hand area (with hand or finger movements). The time interval between the onset of movement in the EMG averages 56 msec. This is shorter than reported by Gilden et. al.

3. The PMP is more subject specific than RP and MP. There are three reasons for the differentiation between PMP and MP:

(a) the spatial distribution of the PMP is more widespread and bilaterally symmetrical,

(b) the time of onset differs significantly, the PMP starting earlier than the MP,

(c) the reverse polarity, PMP being positive, while MP is negative. This reversal of polarity cannot be explained by a sink with a source in the depth of the central sulcus because the positivity is even more marked in experiments with arm movements, the arm representation field being at the surface of the precentral gyrus.

- 253** Defayolle, M., & Dinand, J. Quelques aspects psychophysiologiques de la vigilance. [Some psychophysiological aspects of vigilance.] Le Travail Humain, 1969, 32, 45-54.

Some psychophysiological aspects of vigilance. Effects of hour and duration on a vigilance task were studied with ten subjects undergoing some psychophysiological measures: 1. The performance deteriorations and the variations of physiological indexes seemed greater by night, with exceptions however in some subjects. 2. Physiological indexes enable to estimate two complimentary aspects of vigilance. The first one, the intensive aspect, accounts for circadian fluctuations and for subject's endeavour: it chiefly appears in changes both in heart rate and evoked potential latency. The selective aspect corresponds to vigilance focalization and can be estimated by changes in evoked potential magnitude. Coupling evoked potential measures and a double task performance (a primary task plus counting synchronizing signals) appears as an expedient method for estimating these two factors of vigilance. It can be a good implement for studying mental load. 3. Heterogeneity between subjects in structures of physiological measures may make it better to study subjects individually, each one being his own standard so as to observe several simultaneous variables for accounting for vigilance state or mental load.

- 254 Defayolle, M., Dinand, J. P., & Gentil, M. T. Averaged evoked potentials in relation to attitude, mental load and intelligence. In W. Singleton, J. Fox & D. Whitfield (Eds.), Measurement of man at work, London: Taylor & Francis, 1971.

What conclusions do we have concerning the efficiency of the method of evoked potentials, applied to ergonomics research? We have seen its contribution to measuring mental load, and the abilities of operators. However, we would not suggest that it possesses an absolute objectivity although it is a physiological measure. Indeed, we saw that very subjective phenomena, such as attitudes, may greatly affect evoked potentials. Only the simultaneous study of performance, of subjective feelings, and of evoked potentials has been able to show this effect. Evoked potentials have the status of a performance measure in an accessory task, and therefore they are as difficult to interpret. The originality and the interest of the method consist in the fact that it enables us to assess the operator's transmittance without requiring a measure of some effector system (Callaway, 1969). Thus, performance measures, operator interviews and electrophysiological records are complementary methods.

- 255 de la Pena, A., Zarcone, V., & Dement, W. C. Correlation between measures of the rapid eye movements of wakefulness and sleep. Psychophysiology, 1973, 10, 488-500.

Literature review suggested that certain properties of the REMs of wakefulness and REM sleep show changes with experience and/or maturation. A positive correlation was predicted to obtain between measures of REM sleep intensity and waking information search organization/activity in normal human adults. A correlational study of the REMs of sleep and wakefulness in 9 college-age Ss corroborated the hypothesis. Percentage REM sleep did not correlate significantly with any of the waking REM measures. Implications of the results for current theories and future research on REM sleep-waking perception interrelationships were described.

- 256 Delfini, L. F., & Campos, J. J. Signal detection and the "cardiac arousal cycle." Psychophysiology, 1972, 9, 484-491.

The hypothesis was tested that different phases of the cardiac cycle would be associated with differences in either sensory capacity or response bias, as estimated by signal detection analyses. Each of 10 subjects was given 800 signal (SN) and 800 non-signal (N) trials randomly distributed throughout the cardiac cycle. The signal was a 35 msec duration, 1000 Hz tone, which was preceded by a 1 sec warning light. Electrocardiograph (EKG) cycles were subsequently divided into four phases, and the phase during which the SN or N trial fell was determined. Signal detection analyses performed on auditory sensitivity (d') and estimate of response bias (Criterion Location) showed no measurable effect of EKG phase on either parameter. Results are discussed in terms of recent neurophysiological findings of cardiac rhythmic input to the nucleus tractus solitarius (which can inhibit cortical arousal), but little cardiac rhythm is observed in the output. These considerations imply that "cardiac cycle arousal effects" are likely to be minute or nonexistent.

- 257** Delse, F., Marsh, G. R., & Thompson, L. The contingent negative variation as a pre-motor potential. Psychophysiology, 1970, 6, 619. (Abstract)

The order of magnitude of slow potential shifts was: easy trial shifts greater than hard incorrect trial shifts greater than hard correct trial shifts. This order of magnitude was inversely related to the inferred degree of attention paid to the differential stimuli and directly related to the probable importance of the motor response. This result, as well as recent findings from other laboratories, has led to the supposition that the human vertex slow potential shift is primarily a "pre-motor potential."

- 258** Delse, F. C., Marsh, G. R., & Thompson, L. W. CNV correlates of task difficulty and accuracy of pitch discrimination. Psychophysiology, 1972, 9, 53-62.

Measured the contingent negative variation (CNV) for 5 male and 5 female psychology students during a pitch discrimination task with 2 levels of difficulty. Results show that females had larger CNVs during easy trials than during difficult, and larger CNVs for difficult trials in which they made incorrect judgements than for those in which they made correct ones. The effect of difficulty and of correctness on the CNV is interpreted as a distraction phenomenon.

- 259** Dermer, M., & Berscheid, E. Self-report of arousal as an indicant of activation level. Behavioral Science, 1972, 17, 420-429.

Activation level is typically assessed via the measurement of those physiological variables reputed to be activation indicant. To investigate the usefulness of self-reports of arousal level as an alternative means of activation measurement, 51 Ss made hourly reports of their subjective level of arousal while awake, across a four-day span. A circadian rhythm (about 24 hours) was detected by inferential statistical methods. Additionally, while the 24-hour chronogram depicting the self-report time series may be approximated by a cosine function attaining a single maximal value, our analyses indicated a function attaining local maxima at 13:20 and 19:40 to be more accurate.

The finding that both self-report and physiological measures of arousal may be approximated by circadian functions which attain maximal levels during the middle of the wakefulness cycle suggests that self-report as an activation indicant has some degree of construct validity and may be useful in the test of hypotheses requiring activation measurement of free ranging humans over temporally extended periods. It was also suggested that oral temperature may be a valuable but neglected activation indicant since the circadian variations in the present self-report data and those in previously published oral temperature time series seem to be approximated by functions which share a 24-hour periodicity and attain a maximal value at about 17:39.

- 260 deSwart, J. H., & Das-Smaal, E. A. Relationship between SCR, heart rate and information processing. Biological Psychology, 1976, 4, 41-49.

This study was designed to investigate the relationship between the amount of information processing in concept learning (CL) and autonomic physiological activity as measured by skin conductance response (SCR). Heart rate (HR) was also measured. Two conceptual rules were used: a conjunctive and an inclusive disjunctive concept. The results indicated that the SCR rose with increasing amount of information processing at the feedback during CL. Furthermore, it was shown that SCR increased with increasing difficulty of the conceptual rule. HR appeared not to vary with amount of information processing, nor with type of concept. In the conjunctive series, however, there was a significant difference between HR at stimulus presentation and HR at feedback.

- 261 Dewan, E. M. Cybernetics and attention. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

The requirements for precision in aerospace technology have increased in an unprecedented manner because of what has become known as 'the space age.' This need for better control systems which can function in vastly differing environments has given a great impetus to the development of such fields as adaptive control theory, optimum filtering, and the associated problems of process identification. These concepts will be described in some detail below. It will be shown that they have given rise to devices exhibiting a certain degree of 'artificial intelligence' which are of interest in regard to 'attention.'

Another important concept for understanding certain aspects of brain waves (and biology in general) is 'mutual entrainment'. This will be illustrated by an example in technology and the relevance of this phenomenon to the general problem of self-organization will be explored.

There will be some discussion concerning a 'computer model' for the function of sleep which suggests that there may possibly be very important connections between acquisition of certain stages of sleep and the ability to 'pay attention' in a certain appropriate manner.

The concluding part of the paper will describe a cinematic demonstration, presented at this conference, which concerns the relation between eye position, occipital alpha activity and attention.

202 Dichgans, J., & Jung, R. Attention, eye movements and motion detection: Facilitation and selection in optokinetic nystagmus and railway nystagmus. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

1. The influence of attention on eye movements and motion detection has been investigated by the recording of optokinetic nystagmus (OKN) and the psychophysical scaling of velocity perception.

2. OKN is altered by attention in two ways: (a) Facilitation by visual attention to the moving stimuli, which can be adequately followed in this condition by the slow nystagmic phase up to stimulus velocities of 50-90 degrees per second. (b) Visual selection with foveal fixation of single moving objects and adequate pursuit in a panorama containing objects with different and varying velocities.

3. Two mechanisms of motion detection were studied by quantitative methods and were separated by voluntary alteration of attention and fixation: afferent motion detection by visual inflow from moving retinal images results in excessively high velocity perception: efferent motion detection by oculo-motor outflow from ocular following movements causes adequate velocity perception corresponding to real stimulus velocities. Only the oculomotor mechanism appears dependent upon attentive facilitation.

4. Afferent velocity perception from moving retinal images during diminished attention or fixation of stationary objects is exaggerated, by a factor of 1.6-1.9, when compared with efferent velocity estimation during attentive eye following.

5. The slow phase of OKN shows adequate following at stimulus velocities of 50-90 degrees per second, but only for short periods of optimal attention. Spontaneous slowing of tracking movements occurs together with irregular periodic slackening of attention and blurred vision. More marked slowing is caused by auditory distraction, visual imagination and other modifications of the intention to look at the moving objects.

6. Recordings of railway nystagmus demonstrate the selective function of visual attention, fixation and pursuit. The visually interesting object is selected and the eye movements precisely track its waxing and waning velocity. Foveally fixated objects dominate motion perception, although retinal images may show opposing movements in the fore-and background of the pursued object. Lengthy ocular pursuit results in adequate reproduction of the changing velocities of the selected object over large parts of the field of regard, and is represented by round and S-shaped slow phases.

7. The results have been discussed in relation to attentive mechanisms of intentional selection, vigilance, distraction and to the constancy of space perception with saccadic suppression during the rapid phase of OKN.

- 263 Dimond, S. J. Vigilance and split-brain research. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

In the attempt to find systems of the brain responsible for vigilance performance it is shown in studies of the capacity of the normal person that the watchkeeping functions at the two sides of the brain differ in certain important respects. The view is expressed that there are two different hemisphere vigilance systems of the brain. This has important implications for theories of vigilance because theory which applies to one may not apply to the other. Studies of split-brain man show differences between the performance of the two hemispheres and in addition reveal gross failures of vigilance performance associated with the total-split condition but not with partial section preserving the splenium. The defect can be characterized as 'holes of consciousness', appearing at each side of the brain. The view is expressed that the system which itself unifies the two hemispheres acts as part of the system for visual consciousness which spans the brain and involves the splenium of the corpus callosum.

- 264 Dimond, S., & Beaumont, G. Hemisphere function and vigilance. Quarterly Journal of Experimental Psychology, 1971, 23, 443-448.

A vigilance task in which successive signals were presented to one or other hemiretina, and therefore to one or other cerebral hemisphere, revealed no differences between the hemispheres in terms of detections, although detections declined overall during the experimental period. False positive responses also declined, but consistently more arose from the left hemisphere. There was also a difference in the detection of signals received through the nasal and temporal hemiretinae, the temporal hemiretina showing superiority in detection rate throughout the experiment. This finding may provide a new and more economical approach to the tunnel vision phenomenon.

- 265 Dimond, S. J., & Beaumont, J. G. Differences in the vigilance performance of the right and left hemispheres. Cortex, 1973, 9, 259-265.

A vigilance task was presented to either the right or left hemisphere alone by means of a divided visual field technique. The left hemisphere was found to be superior in detection and to give rise to fewer false positives. Handedness was found to be related to performance in the right hemisphere group. It is argued that the results suggest the presence of two vigilance systems within the brain, a primary system operating initially at a high level, showing decrement with time, and associated with the left hemisphere, and a secondary system showing no decrement, but operating at a lower level, associated with the right hemisphere.

- 266** Dolce, G., & Waldeier, H. Spectral and multivariate analysis of EEG changes during mental activity in man. Electroencephalography & Clinical Neurophysiology, 1974, 36, 577-584.

Obtained EEG recordings of 10 healthy Ss during rest with eyes closed, rest with eyes open, mental arithmetic, and reading. Spectral analysis and multivariate statistical analysis of spectral values yielded the following results. (a) The percentage of alpha intensity decreased during eye-opening and both mental activities, but did not allow any differentiation between arithmetic and reading. (b) A significant increase in relative beta intensity was found during eye-opening. A further increase occurred during reading, but not during mental arithmetic. (c) An increase in theta percentage during reading and an increase in delta percentage during arithmetic were characteristic for these tasks. (d) The statistical analysis of spectral values of EEG showed a different organization of the EEG in frequency bands. During arithmetic and reading a more complex organization of the EEG within the fast frequencies and changes in the distribution of frequency bands in the subalpha range were found.

- 267** Donald, M. W. Electrocortical correlates of fixed foreperiod decision tasks. Unpublished doctoral dissertation, McGill University, 1968. (Cited by L. Karlin, Cognition, preparation, and sensory evoked potentials. Psychological Bulletin, 1970, 73, 122-136.)

- 268** Donald, M. W. Direct-current potentials in the human brain evoked during timed cognitive performance. Nature, 1970, 227, 1057-1058.

Walter et al. observed that when a human subject is presented with two sequentially paired stimuli so that the first serves to signal the occurrence of the second, a negative D. C. shift occurs during the interval between the stimuli in an averaged scalp EEG recording; he termed this phenomenon the "contingent negative variation" (CNV). CNV is frequently elicited with fixed foreperiod decision tasks, which may be said to include a "hold" phase, from the warning signal (WS) to the task stimulus (TS), and an "operate" phase, following the TS and terminating with the subject's response (R) to the TS. CNV definitely occurs during the hold phase, so long as the subject is motivated and the task is sufficiently difficult, but it has not been demonstrated that CNV is present during the operate phase. The tasks used in previous experiments have been so simple that TS and R occurred virtually simultaneously, and it could not be determined whether the termination of CNV covaries with the TS (the end of the hold phase) or with R (the end of the operate phase). In these experiments CNV was averaged during several complex cognitive tasks with considerably longer operate phases, and found to persist throughout the operate phase, for periods ranging up to 8 sec after the TS.

- 269** Donald M. W. Jr., & Goff, W. R. Attention-related increases in cortical responsivity dissociated from the contingent negative variation. Science, 1971, 172, 1163-1166.

Certain tasks which increase attention to stimuli also elicit the contingent negative variation and increase the amplitude of the P300 component of the sensory evoked response. Therefore it appeared possible that the contingent negative variation and attention-related increases in P300 are either confounded by artifact or generated by common neural mechanisms. The fact that we have recorded attention-related increases in P300 amplitude independent of corresponding systematic changes in contingent negative variation indicates that neither of these possibilities is correct. The two phenomena are independently variable modulations of cortical activity.

- 270** Donald, M. W., & Goff, W. R. Contingent negative variation and sensory evoked responses. Their interaction and relationship to auditory discrimination. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 109-117.

The CNV, the P300 wave and various other somatic and auditory evoked response components were monitored simultaneously with accuracy in a perceptual identification task. Care was taken to avoid confounding sensory evoked responses with the return of CNV to pre-trial baseline.

The amplitudes of both CNV and the P300 wave were positively correlated with spontaneous fluctuations in accuracy, but the correlation between CNV and P300 was not significant, even without controlling their mutual covariance with accuracy. Other somatic and auditory evoked response components were not consistently correlated with either accuracy or CNV amplitude.

When variation in P300 was experimentally induced (by changing the task relevance of a stimulus), increases and decreases were demonstrably independent of changes in CNV amplitude or wave form.

A change in the task relevance of a stimulus modified the recovery of P300 from a previous stimulus; increased CNV amplitude had no comparable effect on recovery.

Spontaneous increases in P300 followed a different moment-to-moment time course from changes in CNV amplitude.

The implied functional separation of P300 from CNV suggests two brain mechanisms are supportive of successful cognitive performance, the first related to later stages of sensory information processing, the second to maintenance of a response set.

- 271** Donchin, E. Average evoked potentials and uncertainty resolution. Psychonomic Science, 1968, 12, 103.

Two Ss were presented with a series of near threshold flashes of light. They reported in which of 8 different positions each flash appeared, and the degree of judgement certainty. Average evoked potentials to the flashes were also recorded from the occiput. A positive going wave with latency to the peak of 250 msec appeared when the S was certain about his judgment, whether or not he was correct.

- 272** Donchin, E. Discriminant analysis in average evoked response studies. The study of single trial data. Electroencephalography and Clinical Neurophysiology, 1969, 27, 311-314.

The data presented suggest that it is possible to make meaningful comparisons between EEG records obtained with a single presentation of the stimulus and the average evoked potential. The technique for measuring evoked response similarity assumes that each record represents a point in a multi-dimensional space, and similarity is defined as the Euclidean distance in this space.

- 273** Donchin, E. Methodological issues in CNV research. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 3-17.

In this review some methodological difficulties currently prevalent in CNV research have been identified. The need for standardized methodology has been emphasized specifically together with the need for multiple-electrode placements and for careful behavioral and instrumental technology and for thoughtful attention to the nature of the data when they are analyzed. These problems do not necessarily characterize most of the work in the field; on the contrary, there is much that is exciting and well done in the recent work on the CNV. Unfortunately, research on CNV is somewhat like playing the recorder, an instrument that is extremely easy to play at an elementary level, but which is exceedingly difficult to play well. At the root of the difficulty is the very simplicity of the instrument. Given some basic equipment and willing subjects, the recording of CNV data is relatively easy. The important question, however, is the degree to which the obtained data are relevant to some meaningful and important question and are obtained in a competent way to provide an answer to that question. The primary condition for achieving this goal is to perform experiments that are very finely attuned to the psychological processes which the CNV is presumably tapping. Although the electronic technology which provides us with our amplifiers and computers is becoming increasingly sophisticated, our methodology and behavioral control technology must yet be developed to a parallel level.

- 274** Donchin, E. Brain electrical correlates of pattern recognition. In G. F. Inbar (Ed.), Signal analysis and pattern recognition in biomedical engineering. New York: John Wiley, 1975.

The application of signal-averaging technology to the study of population responses of neuronal aggregates is discussed. The use of these techniques in the study of cortical manifestations of cognitive activity is described in some detail. Specifically the following assertions are made: a. Stimuli which trigger a decision in the subject elicit an evoked response in which a positive going component with a latency of 200 msec is enhanced. b. Anticipated stimuli, and self paced voluntary responses are preceded by a slowly rising negative going wave, which peaks just prior to the critical event. c. The positive going "decision wave" and the negative going "expectancy" and "preparation" waves are independent. Some speculations are offered concerning the functional significance of these phenomena.

- 275** Donchin, E. On evoked potentials, cognition, and memory. Science, 1975, 190, 1004-1005.

Once the source of the observed differences is identified as P300, it should be noted that the literature suggests that while P300 clearly manifests an act of decision-making it provides little information as to the contents of that decision. Thus, the differences observed by Begleiter and Porjesz may indeed reflect the fact that a decision concerning stimuli of medium brightness was made by the subject. However, these differences cannot be considered related to the specific physical attributes which the subject has ascribed to the stimuli. In other words, the ERP waveforms cannot be considered as carrying the specific "memory traces" for stimulus brightness. On the evidence at hand, all that can be said is that the subject (perhaps) searched his memory. While it might be the case that neural patterns such as P300 reflect "the activation of memory traces about specific experience," there is no evidence for this proposition in Begleiter and Porjesz's report.

- 276 Donchin, E. (Ed.), The relationship between P300 and the CNV. A correspondence and an experimental report. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

The experiment consisted of a series of trials, grouped in runs. On each trial S was presented with one of two tones. During Reaction Time (RT) runs S had to press the button in her right hand following a high tone and the button in her left hand following a low tone. During the Predict (P) runs, the S was to guess which of the two tones would be presented on the following trial. During RT trials, the tone was repeated if the subject failed to respond within a specified interval. During P trials the tones were always repeated. Within any run some of the tones were preceded, at an interval of 1500 msec, by a warning flash from the photic stimulator. On other trials the tones were presented without warning. S was always informed by the television monitor whether she would be forewarned of the arrival of the tone. Display 'A' informed S that arrival of the tone would be preceded by the warning flash. Display 'B' indicated absence of the warning flash. One of the two patterns was always on.

The working group felt that this demonstration may assist in an eventual resolution of the issue of the relationship between pre- and post-stimulus electrocortical activity. The experimental design was elaborate, so that precautions must be kept in mind.

Two major aspects of this collaborative research emerge: (1) Careful design of experiments is critical, in order precisely to identify and quantitatively manipulate the independent variables. (2) The dependent variables (the electrical events, negative and positive) must be treated in a topographic domain. [Editor's note: e.g., in an electro-anatomical framework, J.R.K.]. Multiple recording areas, to include lateral as well as midline placements, are necessary for adequate description of electrocortical processes.

A full experiment based upon 12 subjects was conducted subsequent to the Congress and appears as a paper: 'On the independence of the CNV and P300 components of the human averaged evoked potential.' (Donchin, E., Tueting, P., Ritter, W., Kutas, M. and Heffley, E. (1975). *Electroencephalogr. Clin. Neurophysiol.* 38, 449-461.) This study confirmed: (1) P300 is not influenced by the presence or absence of a warning stimulus; (2) the distributions of P300 and CNV are topographically different.

- 277 Donchin, E., & Cohen, L. Averaged evoked potentials and intramodality selective attention. Electroencephalography & Clinical Neurophysiology, 1967, 22, 537-546.

Attempted to determine the effects of attention on average evoked potentials when there was no general change in the alertness of the S, and no peripheral gating of sensory inputs. Twenty-two Ss viewed a 50-msec flash of light superimposed on a fluctuating background. In 1 of the 2 experimental conditions, the S ignored the background alternations and responded to the flash; in the other condition, the S ignored the flash and responded to the fluctuations in the background. It was found that the stimulus to which the S responded elicited an average evoked potential with a considerably enhanced late positive component (latency to peak 250-300 msec).

- 278** Donchin, E., & Cohen, L. Anticipation of relevant stimuli and evoked potentials: A reply to Naatanen. Perceptual & Motor Skills, 1969, 29, 115-117.

Naatanen's comments on Donchin and Cohen's study of selective attention seem to derive from a failure to appreciate the relationship between the negative shifts in cortical potentials reported by Naatanen, and Grey Walter's CNV. Naatanen's assertion that slow negative cortical shifts reflect generalized cortical activation is discussed.

- 279** Donchin, E., & Cohen, L. Further reply to Naatanen. Perceptual & Motor Skills, 1969, 29, 270.

To suggest that the difference we observed is due to the relative periodicity of the stimuli is to suggest an interpretation of the data. This is perfectly permissible, but it is not a disputation over data. It is, indeed, possible that had we used a "completely randomized stimulus sequence" as Naatanen suggests, we would have obtained different results. This is an empirical question, and we would be very interested to know what Naatanen finds when he conducts such an experiment.

- 280** Donchin, E., & Cohen, L. Evoked potentials to stimuli presented to the suppressed eye in a binocular rivalry experiment. Vision Research, 1970, 10, 103-106.

Our conclusion at this point has been that "division of attention" from the flash to the rivalry target has such a decided effect on the Visually Evoked Cortical Potentials (VECP) to the flash that it would not be possible to study the effects of binocular rivalry on the VECP by this technique. We therefore abandoned this study. A detailed report of subsequent investigations of this intra-modality selectivity has been published (DONCHIN and COHEN, 1967). We have shown that the effect is not unique to binocular rivalry but is obtained with other visual targets. SMITH, DONCHIN, COHEN and STARR (in press) have described a similar effect for auditory stimuli.

Cobb et al., in a very similar situation have obtained a clear response to the flashes. The VECPs to flash were characterized by a long latency component (peaking about 250 msec after the stimulus). The amplitude and latency of this component were independent of the dominance status of the eyes. Why the difference between our results and those obtained by Cobb and his coworkers? The design of the two studies differed in one detail. Cobb et al. presented stimuli when the subject pressed the switch and the subject did not know which eye would be stimulated. On the other hand, we presented stimuli at random intervals and to the same eye. There was thus a clear temporal relationship between the flashes and the task the subjects were performing in the Cobb et al. study, and no such relationship in our study. We suggest, therefore, that the difference between our results and theirs is due to the contingency between the subject's response and the presentation of the flash. The major wave reported by Cobb et al. is probably P300. Thus again, as in our results, the data reflect not so much the effect of binocular rivalry on the VECP as they do the contingency structures of the task and the degree to which the subject pays attention to the flash.

We think this point is worthy of note because in AEP work it is imperative to realize the important control that such variables as the task relevance of the stimuli exercise over the waveshape and form of the VECP. A "purely visual" experiment using the VECP technique must assure that there is no direct relationship between the timing of stimuli and the contingency structure of the experiment.

- 281** Donchin, E., Gerbrandt, L. A., Leifer, L., & Tucker, L. Is the contingent negative variation contingent on a motor response? Psychophysiology, 1972, 9, 178-188.

Ten subjects participated in an experiment in which each was presented with series of paired stimuli separated by 1000 msec. The first stimulus was a click. The second stimulus was either of two visual patterns, concentric circles or a star figure. Figure selection on each trial was determined by a random procedure.

There were four experimental conditions: 1) Subjects pressed a switch following the presentation of either figure. 2) Subjects pressed a switch following the presentation of the star only. 3) Subjects guessed prior to the clicks, which figure would appear as S2; no overt motor response was required. 4) Subjects had to add 7 to a cumulative sum following a star, and subtract 7 following the circles; no overt motor response was required.

Using data obtained from a vertex to linked ear derivation we conclude that the CNV is not contingent on a motor response to S2.

The electrical potentials recorded following S2, and in particular the positive-going "resolution" of the CNV seemed to vary systematically with the experimental conditions. An application of Tucker's three-mode factor analysis to this CNV is reported.

- 282** Donchin, E., Gerbrandt, L. K., Leifer, L., & Tucker, L. R. Contingent negative variations and motor responses. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 187-190.

Grey Walter's original report (Walter et al. 1964) of a slow negative wave recorded over the frontal areas of human subjects during the foreperiod in a reaction time experiment has triggered a considerable number of investigations. The consensus of most has been that the general validity of the phenomenon cannot be doubted. Although a variety of artifacts which might "look like a CNV" have been described, it is possible to control for most of these artifacts and yet obtain a CNV.

The agreement on the fundamental validity of the observation did not lead to agreement on the nature and on the functional significance of the CNV. As Low has stated in a recent symposium (1969) "the CNV is contingent upon something; the question is, upon what?" Whereas Grey Walter tends to stress the contingency between the stimuli and the relation between the CNV and "expectancy", others have stressed the fact that, in the majority of CNV experiments, the second stimulus in the series is followed by a motor response. A motor response, as Kornhuber and Deecke (1965) and Vaughan et al. (1965) have shown, is preceded by a negative-going slow potential and this has led to the suggestion that the CNV and the motor potential are identical. In view of this controversy, it seems important to determine the degree to which the motor response following the imperative stimulus is truly necessary for the production of a CNV. In spite of the importance of this question, only a few sporadic attempts to resolve the issue have been reported. Most agree that the CNV can be elicited even when a motor response is not required. We felt, however, it would be useful to conduct a systematic study in which the same subjects will be presented with the same stimulus situation, varying the involvement of the skeletal musculature in the response of the subjects to the imperative stimulus.

- 283** Donchin, E., & Hering, R. I. A simulation study of the efficacy of stepwise discriminant analysis in the detection and comparison of event related potentials. Electroencephalography and Clinical Neurophysiology, 1975, 38, 51-68.

Cortical average evoked potentials were simulated by summing five damped sinusoids. The characteristics of these "evoked" responses could be manipulated by changing parameters of the sinusoids. The synthesized signals were mixed with noise processes whose power and band-width were manipulated. Thus data were generated to simulate a variety of conditions which could conceivably occur in an experiment on evoked potentials. Stepwise discriminant analysis (BMD07M) has been applied to these simulated data in an attempt to determine the degree to which the program identifies, in a sensible manner, the differences we introduced into the synthesized evoked responses.

The simulation results indicate that stepwise discriminant analysis can indeed be an efficacious tool in research on evoked potentials. The program does detect differences in evoked potentials. It can be used, with some reservations, to identify the components of an evoked potential which the experimental variables have affected. In a special set of simulations we have attempted to determine the degree to which stepwise discriminant analysis could serve to detect the presence or absence of an evoked potential. These simulations show that the score of an average evoked potential on the suitable discriminant function reflects the presence or absence of the evoked potential in the data. The implications of this finding to the use of evoked potentials in sensory sensitivity testing were evaluated in studies of the effect on them of stimulus intensity.

- 284** Donchin, E., Johnson, R., Hering, R., & Kutas, M. Covariation of the magnitude of the CNV and P300 as a function of the subject's task. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event Related Slow Potentials of the Brain. Bristol, England, 1973, Bristol: John Wright, 1976.

The above results indicate that by varying S's task it is possible to manipulate the distribution over the scalp of both the CNV and the P300 as well as the overall amplitude of these two components. Within each task, the magnitude of the components, though not their scalp distribution, is modulated by conditions under which the S is performing the task. In two tasks requiring a motor response, we find right-hemisphere potentials exceeding the left-hemisphere potentials. In one task, not requiring a motor response, this relationship is reversed. However, in all tasks we find that the amplitude of the distribution can be shifted up or down as a function of the complexity of the sequence generating rule used to determine the succession of trial outcomes. In any event, P300 and CNV areas appear to be affected in a similar manner by all these manipulations.

We speculated about the implications of the effects of the sequence on P300 amplitude in our previous report (Donchin et al., 1973b). For the present it is noteworthy that similar considerations might apply to the CNV. This of course revives the possibility that there is a strong relationship between these two components of the human evoked response. Needless to say, the demonstration of such a correlation does not imply a common casual source.

- 285 Donchin, E., Kubovy, M., Kutas, M., Johnson, R., Jr., & Herning, R. Graded changes in evoked response (P300) amplitude as a function of cognitive activity. Perception & Psychophysics, 1973, 14, 319-324.

Used a stepwise discriminant analysis with 10 undergraduates to demonstrate that the amplitude of P300 is a graded function of the complexity of information processing required of an S following a stimulus. This relationship between cognitive complexity and P300 was apparent only when S was not pressed to generate fast and accurate discriminant responses to the stimuli. Under a reaction-time regime, a large P300 was elicited independently of stimulus predictability or cognitive complexity. It is concluded that P300 is a measure of the amount of activity of a general purpose cortical processor.

- 286 Donchin, E., & Kutas, M. Preliminary observations on the effects of response parameters on pre-response potentials. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

All conclusions at the present are based on visual inspection of superimposed records averaged for each S and obtained from right-handed Ss only. With these restrictions the results may be very simply summarized. We find that the amplitude over the left motor cortex of the potentials (all components) are larger than the corresponding potentials obtained over the right motor area, when S responds with his right hand. This asymmetry between the hemispheres disappears when S responds with his left hand. The above result appears at all force levels.

In general, we find that the force level has no effect on the amplitude of the potentials, the amplitudes at all three levels used, for each of the right-handed Ss is identical. We also note that the presence or absence of the feedback stimulus at the termination of the movement has no immediately obvious effect on the potentials.

- 287 Donchin, E., Kutas, M., & McCarthy, G. Electrocorical indices of hemispheric utilization. In S. Harnad et al. (Eds.), Lateralization in the nervous system. New York: Academic Press, in press.

We review the evidence for the proposition that differences between the electrical activity recorded at homologous scalp locations over the two hemispheres can be used to index hemispheric utilization. There seems to be adequate support for the assertion that the ratio of EEG power over the hemispheres is sensitive to task variables. The direction of the difference is to some extent consistent with predictions derived from contemporary ideas about hemispheric specializations. Of the various ERP parameters studied, the sturdiest results come from investigations of anticipatory potentials which appear to be asymmetric, again, in the predicted direction.

These trends are far from conclusive. Some methodological problems were reviewed. Attention should be paid to the independent validation of the behavioral effects of experimental instructions; to the greater sensitivity of within-group repeated measures designs; to the choice of EEG parameters for study; and to the measurement and analysis of data.

Data are presented which demonstrate that (a) slow potentials preceding a voluntary self-paced motor response are largest over the hemisphere contralateral to the responding hand (at least in dextrals); (b) the pre-response asymmetry can coexist with "cognitive" anticipations which are symmetric; (c) the pre-response asymmetric readiness potentials appear to be followed by a prolonged potential shift with a polarity which is apparently inverse to that of the motor potential; (d) when the information processing load is increased some specialization laterality seems to occur in the CNV; (e) both this CNV negativity and task-related shifts in power in the alpha band appear mostly as modulations of left hemisphere activity rather than as reciprocal changes in hemispheric activities.

- 988 Donchin, E., & Lindsley, D. B. Cortical evoked potentials and reaction times. Electroencephalography and Clinical Neurophysiology, 1965, 18, 523. (Abstract)

The purpose of this study was to determine the manner and extent to which reaction time (RT) to visual stimuli relates to latencies and wave components of the average evoked potentials (AEP) elicited by the visual stimuli. It is assumed that the speed of the reaction is in part a function of the alertness of the subject, thus potentials elicited by flashes to which reactions are slow, or fast, should reflect the recently reported relationships between the degree of alertness of the subject and his AEP.

Different AEP patterns were elicited by flashes which produced different reaction times; shorter latencies were associated with shorter RTs. Cortical responses time-locked to the motor response were also studied, including activity preceding and following the response.

- 5 260 Donchin, E., & Lindsley, D. B. Visually evoked response correlates of perceptual masking and enhancement. Electroencephalography and Clinical Neurophysiology, 1965, 19, 325-335.

For all interflash intervals in the brightness enhancement range the response to paired flashes was approximately a linear sum of the responses to the two flashes when presented alone. Thus when the response to the second, brighter, flash (BF) was subtracted from the response to the pair, the residual represented the response to the first, or test flash (TF). For interflash intervals in the masking range, the residual shows no detectable response to the TF after subtracting the response to the BF.

These results suggest that retroactive brightness enhancement represents an interaction between the neural representations of the two flashes, while the masking phenomenon is due to a displacement of the neural response to the TF by the response to the BF and that this interaction occurs prior to the stage at which the average evoked potential is elicited.

- 220 Donchin, E., & Lindsley, D. B. Average evoked potentials and reaction times to visual stimuli. Electroencephalography and Clinical Neurophysiology, 1966, 20, 217-223.

Average evoked potentials to brief light flashes were recorded from occipital, vertex, temporal and orbital leads in ten subjects during a reaction time study. Subjects performed under two conditions, with and without knowledge of results.

The amplitude of the average evoked potentials was related to reaction time. For any given sequence of reaction times, faster reactions were associated with larger amplitude average evoked potentials. Knowledge of results shortened reaction times and increased the magnitude of average evoked potentials.

The diffuse and non-specific character of the main component of the average evoked potential appears to reflect changes in cortical excitability associated with the variability of reaction time. This result has been interpreted in relation to the non-specific arousal and alerting mechanism.

- 201 Donchin, E., McCarthy, G., & Kutas, M. Electroencephalographic investigations of hemispheric specialization. In J. E. Desmedt (Ed.), Progress in clinical neurophysiology. Vol.3. Language and hemispheric specialization in man: Event-related potentials. Basel: Karger, 1977, in press.

In this chapter we review studies of the electrocortical manifestations of hemispheric specialization in humans - focusing on the relation between linguistic performance and hemispheric activities. In all of the reviewed studies, measures of the human electroencephalogram (EEG) or event-related potentials (ERPs) are used as dependent variables. This is an extensive revision of an earlier review which considered literature published before 1975 (Donchin, Kutas and McCarthy, 1976). In the present review we have paid closer attention to the correlation between linguistic function and the electrical activity of the brain. Our previous review considered in some detail methodological problems which confront investigators in this area of research. This discussion is not repeated here and interested readers should consult the earlier paper.

The papers reviewed here utilize the same logic - the scalp distribution of some EEG parameter is the source of inferences about the differential utilization of distinct cortical regions during the normal processing of information by the brain. The underlying assumption is that certain aspects of scalp recorded activity are correlated with "utilization". Unfortunately, the physical properties of a "utilized" population of cells are not very well understood and the effects such activities may have on scalp recording is even more in doubt. Naturally, the use of scalp recordings in the study of hemispheric utilization is fraught with difficulties.

- 202 Donchin, E., & Smith, D. B. D. The contingent negative variation and the late positive wave of the average evoked potential. Electroencephalography and Clinical Neurophysiology, 1970, 29, 201-203.

Stimuli that are task relevant elicit an averaged evoked potential (AEP) that shows an enhanced positive component (P300) with a peak latency between 200 and 300 msec. The contingent negative variation (CNV) usually terminates with a positive wave with a latency of approximately 300 msec. The possibility that these two phenomena are related was investigated. The data indicate that when conditions are appropriate, both the CNV and P300 can be obtained in the same experimental situation, and their relationship should be further elucidated.

- 293 Donchin, E., & Sutton, S. The "psychological significance" of evoked responses: A comment on Clark, Butler, and Rosner. Communications in Behavioral Biology, 1970, 5, 111-114.

Clark, Butler, and Rosner (1969) reported a dissociation, under cyclopropane anesthetic, between behavioral thresholds and thresholds for average evoked potentials recorded from human scalp. They stated that their findings "raise doubts about the psychological significance of evoked potentials." It is our contention that in contrast to their sweeping conclusions their data are inadequate, their methodology is faulty, and alternative explanations have not been explored. Our critique distinguishes the early and late components of the average evoked potentials. For the early components, we find the sample data they present extremely "noisy" and unconvincing.

The data for the late components are convincing. However, they do not lead to the conclusions of Clark *et al.*, because of an experimental design in which behavioral and physiological data are obtained with different procedures and separate sessions. The behavioral thresholds are obtained with a descending method of limits which would tend to yield thresholds which are too sensitive. The evoked potentials are obtained under conditions which would tend to reduce their amplitude---in response to monotonously repeated stimuli unrelated to a demanding task and while under the influence of cyclopropane which made the subjects feel "detached from their environment and...unconcerned with the passage of time." While the behavioral data are also obtained under the influence of cyclopropane, the nature of the task is such as to require careful attention to each stimulus. There is a large literature on human evoked potentials which show that late components of the evoked potentials are highly sensitive to the attentional state of the subject. Some of the requirements that would have to be fulfilled for an adequate exploration of the question raised by Clark *et al.*, are presented.

- 294 Donchin, E., Tueting, P., Ritter, W., Kutas, M., & Heffley, E. On the independence of the CNV and the P300 components of the human averaged evoked potential. Electroencephalography and Clinical Neurophysiology, 1975, 38, 449-461.

We report an experiment designed to assess the interactions between the CNV and the P300 components of human event-related potential. Eight subjects were each presented with series of experimental trials on all of which either a 1200 c/sec or an 800 c/sec tone was presented. There were three independent variables: (a) The presence or absence of a warning flash 1000 msec prior to the tone. (b) The task assigned to the subject - that is subjects were either to make a discriminative response to the tone or, on half the series, to predict prior to the trial which of the two tones would be presented. (c) The predictability of the tone frequency. On half the series high and low tones alternated from trial to trial. On the other series, tones were chosen randomly on each trial.

The data show that the amplitude of the P300 component is not affected by the presence or absence of a warning stimulus. Furthermore, the distributions of P300 and the CNV over the scalp are quite different. These conclusions are supported by a principal component and a discriminant analysis of the data.

We conclude that the CNV and the P300 reflect the activity of functionally distinct cortical mechanisms.

- 285 Donchin, E., Wicke, J. D., & Lindsley, D. B. Cortical evoked potentials and perception of paired flashes. Science, 1963, 141, 1285-1286.

Digital computer techniques have been employed to extract cortical evoked potentials to paired visual stimuli. Changes in the evoked potentials have been related to perceptual phenomena varying as a function of the interval between flashes. Evoked potentials to paired stimuli, which gave rise to perceptual interactions, could be approximated by algebraic summation of the responses to the stimuli when presented separately.

- 286 Doroshenko, V. A., Muraviev, V. I., & Pudovkin, A. I. On evaluation of amplitude changes in the main human EEG rhythms in response to sensory stimulation. Electroencephalography and Clinical Neurophysiology, 1970, 29, 97. (Abstract)

Under these conditions stimulation enhanced alpha waves (during 15 sec after stimulation was started), decreased theta waves (most distinct during the first 15 sec with return to the initial level during the next 4 min) and increased heart rate (time course similar to that for theta waves). Differences in response clarity between the averaged curves of heart rate, alpha waves, theta waves and general EEG were not statistically reliable; i.e., all these parameters proved to be equal for judgment of the presence of a signal.

The authors discuss the evaluation of correlations between rhythm amplitude in the preceding background and clarity of response (for alpha range), as well as confluence of responses in different EEG frequency bands.

- 287 Doskin, V. A., & Lavrent'yeva, N. A. Periody maksimal'noy rabotosposobnosti i sutochnyy ritm fiziologicheskikh funktsiy. [Periods of maximum performance and circadian rhythm of physiological functions.] Sovetskaya Meditsina, 1974, 8, 140-145.

An investigation is made of maximum performance and circadian rhythm of physiological functions in students of the Moscow Medical Institute. It is concluded that periods of high performance are determined by the circadian rhythm of physiological functions.

- 288 Douglas, R. E. Information processing, sinus arrhythmia and academic achievement. Monterey, California: Naval Postgraduate School, March 1972. (NTIS NO. AD-743 732)

This experiment investigated the effect of motivation on sinus arrhythmia, heart beat, and information processing rate. The two way analyses of variance which were performed showed that motivation affected sinus arrhythmia and information processing rate and did not affect heart beat. A system was developed to classify the general patterns that resulted in the measure of sinus arrhythmia as information processing levels increased. This classification system may have eventual use in predicting a student's academic achievement.

- 299** Doyle, J. C., Ornstein, R., & Galin, D. Lateral specialization of cognitive mode: II. EEG frequency analysis. Psychophysiology, 1974, 11, 567-578.

This study reports a frequency analysis of hemispheric EEG asymmetries in normal subjects performing cognitive tasks. Language and arithmetic tasks were expected to engage primarily the left hemisphere; spatial and musical tasks were expected to engage primarily the right hemisphere. Both motor and non-motor tasks were used, e.g. writing a letter and composing a letter mentally. Recordings from temporal leads (T_3, T_4) and parietal leads (P_3, P_4) referred to the vertex C_z were subjected to discrete Fourier transforms; ratios of power from homologous leads ($T_4/T_3, P_4/P_3$) were computed in conventional frequency bands. These ratios (right/left) are significantly higher in verbal and arithmetic tasks than in spatial tasks primarily in the alpha band; the beta and theta bands show this effect less consistently. The delta band shows no such systematic effect of cognitive mode. Considering the alpha band alone reveals a task dependence of the asymmetry 2-5 times greater than we reported earlier for whole band power (1-35 Hz). Whenever a significant task dependence of asymmetry appears in any band, it is in the same direction: the hemisphere primarily engaged in the cognitive activity develops proportionately less power. The requirement of motor output increases the task dependence of alpha asymmetry and lowers alpha power levels.

- 300** Driscoll, J. M., & Lanzetta, J. T. Effects of problem uncertainty and prior arousal on pre-decisional information search. Psychological Reports, 1964, 14, 975-988.

Fifty-four undergraduate Ss at the University of Delaware were presented sequentially 10 decision problems. Prior to making a decision on a problem, S had the option of receiving up to 5 additional information items. Independent variables were the initial uncertainty of the decision problem and prior "emotional" arousal. Dependent measures were the number of information items taken, the utilization of time resources, and S's arousal level (GSR). Neither independent variable affected the amount of information acquisition prior to decision, but differences in problem uncertainty within the high uncertainty conditions were negatively related to information search ($r = -.706$). Decision time increased linearly with problem uncertainty and decreased across sequential problems. In general, decision-making became more facile with increasing experience.

- 301** Droppova, Z. Analyza Vzt'ahu Tepu a Dychania vZat'azovej Situacii. [The analysis of heart rate - respiration relationship under a load situation.] Spravy UEPSAV No. 177, 1973.

In an orienting investigation of heart rate and respiration under load, performance, heart rate and respiration were simultaneously recorded in five situations. The load consisted of following up light stimuli, the sequence of which gradually accelerated. A marked change in heart rate was noted together with a slight change in respiration rate. A comparison of the courses of these parameters indicates their corresponding relationship.

- 302 Dudley, L. M. The effects of arousal and attention on central, autonomic, and behavioral processes (Doctoral dissertation, University of North Carolina at Greensboro, 1971). Dissertation Abstracts International, 1971, 32, 2416B. (University Microfilms No. 71-26935)

The present investigation was conducted primarily to clarify further the dissociative and associative effects of arousal and attention on the evoked cortical potential (ECP), contingent negative variation (CNV), heart rate (HR), and reaction time (RT). A secondary consideration was the evaluation of criticisms directed by Naatanen (1967) to selective attention research.

The experimental paradigm involved a contingency situation. An auditory click (S_1) preceded a light flash (S_2) to which a RT response was required. The time interval between S_1 - S_2 and S_2 - S_1 was randomly varied from 2 to 3 sec. In some conditions, extraneous stimuli (S_E) were presented randomly at the rate of approximately 1 Hz within the S_1 - S_2 and S_2 - S_1 intervals. The maximum number of S_E presented in any one interval was three, the minimum zero.

Changes in arousal were experimentally induced by requiring S to make a RT response to light flashes (relevant stimuli, S_2) under conditions of contingent, noncontingent, and no shock. Attention was varied by requiring S to react to S_2 only, react to S_2 while ignoring S_E (light flashes in the opposite field), and react to S_2 while also counting S_E . The ECPs to both S_2 and S_E were obtained; simultaneously, CNV, HR, and RT were recorded for each of the four Ss under the nine experimental conditions generated by these major independent variables.

Each S's data were subjected to individual analysis in order to assess consistent treatment effects for each S. Changes in the amplitude of the ECP to S_2 as a function of arousal and shifts in attention were found to be statistically significant for all Ss. The ECPs to S_E were also found to be significantly affected by changes in arousal and attention for three of the four Ss. In addition, there was a significant within-6-sec-interval effect on the amplitude of the ECP to S_E for two Ss.

The changes in HR for all Ss were found to be significantly dependent upon arousal level and for two Ss upon shifts in attention. The findings also showed that behavioral performance (RT) was significantly altered by the experimental manipulations of arousal and attention, and in the same direction as the ECP data.

The results in general favor a selective attention interpretation of changes in the amplitude of the ECP to S_2 . The findings of some significant within-interval effects on the amplitude of the ECP to S_E offer some positive support for Naatanen's criticisms of selective attention research. In spite of this, however, the data argue strongly for an interpretation of ECP changes which attributes enhancement to attentional factors in addition to the variation in non-specific arousal. The HR data readily support an interpretation based on activation theory.

- 303 Duffy, E. The psychological significance of the concept of "arousal" or "activation". Psychological Review, 1957, 64, 265-275.

Differences in activation in the same individual are, it is suggested, accompanied by differences in the quality of performance; the relationship may be graphically represented by an inverted U-shaped curve. Further data are needed, however, to establish the validity of this hypothesis.

In the same stimulus situation there are differences between individuals in the degree of arousal. These differences tend to persist, and thus to characterize the individual. Moreover, the easily aroused, or responsive, person shows this responsiveness in many forms.

- 304 Duffy, E. Activation and behavior. New York: John Wiley & Sons, Inc., 1962.

The hypotheses presented here, and the review of the literature undertaken from the point of view of activation theory, have perhaps raised more problems than they have solved. It seems apparent that activation (its degree, its fluctuation and its speed of return to a prestimulus level) is associated with important differences in behavior. It is apparent that differences in activation may be produced by many different factors, ranging from the genes to hormones, drugs and learned responses to cues. There appears to be both some degree of "generality" and some degree of "specificity" in activation, the extent of each remaining an unsolved problem. It is contended, however, that activation is an organismic phenomenon, and that it is recognized as such when we speak of an individual's being relaxed or being excited rather than of a particular system's showing this condition.

Characteristic individual differences in activation, or responsiveness, are suggested as the basis from which certain other differences in behavior may be derived. Extreme differences in the degree of activation, the variability of activation, or the speed of return of activation to a lower level are suggested as characteristic of the functional disorders. Differences in activation in the same individual at different times have been suggested as a factor in differences in sensory sensitivity, various aspects of motor response, and the general quality of performance.

The purpose of the present discussion has been primarily to point out similarities in phenomena which might, without focus upon them, be overlooked. Critical data which would support or deny many of the hypotheses are lacking yet, from reading the results of the investigation of a wide range of topics, there emerges the feeling that the phenomena of activation are of basic significance in the understanding of behavior. Whether the conclusions derived should take the approximate shape that is presented here remains for further investigation to determine. If the image proves to be even partially correct, it will be illuminating in many areas of psychology. If it proves to be altogether wrong, my colleagues will at least have at hand some references which may prove useful in the construction of a better image. Naturally, I myself am a convert to my own thinking.

- 306** Duker, F. A. An investigation into the use of physiological measures for predicting performance times: An application of arousal theory (Doctoral dissertation, New York University, School of Engineering and Science, 1971). Dissertation Abstracts International 1971, 32, 2731B-2732B. (University Microfilms No. 71-29, 669).

The objectives of this study were to investigate the relationship between physiological measures (heart rate, ventilation rate, splenius muscle potential and skin conductance), and performance time on both light and heavy tasks. In particular, the use of these measures to predict performance time was examined. In addition the hypothesized inverted U relationship of arousal theory, individual response specificity (IRS) and the effect of body surface area and a physical fitness index on the measures of heart rate and ventilation rate were examined.

The results of the study indicate that the use of four physiological measures yields a predictive relationship with performance time which is superior to that obtained when only one physiological variable is used as a predictor. However, the relationship lacks statistical significance for most subjects and could not be used as a work measurement tool to adequately predict performance times.

The results gave support to the hypothesized inverted U relationship. However, an inverted U was not found for all subjects on both tasks. When it was found, a pronounced scatter was apparent.

It was also found that individual response specificity existed for most subjects on both tasks. This extended the IRS concept to heavy, strenuous work. In addition, doubt was cast upon the use of body surface area (or a physical fitness index) as a means of eliminating individual differences in physiological responses.

- 306** Dulany, D. E., Jr., & Eriksen, C. W. Accuracy of brightness discrimination as measured by concurrent verbal responses and GSRs. Journal of Abnormal and Social Psychology, 1959, 59, 418-423.

In many subliminal perception experiments some response shows discriminative accuracy at stimulus values below the threshold of awareness determined by classical psychophysical techniques. The procedure is objectionable because the threshold measure admits extraneous variance that the measure of "subliminal accuracy" does not. The measures are not comparable for another reason when one response is the GSR and the other a verbal response because the former is continuous and the latter, as manifested, is discrete. This experiment compares the discriminative accuracy of GSR and verbal response when assessed by the same forced-choice psychophysical technique, a procedure that obtains a discrete index of both responses.

1. Over a range of stimulus values producing from chance (50%) to approximately 99% accuracy of judgment, the verbal response showed significantly higher correlation with the stimulus than did the GSR.

2. Within the range of stimulus values producing from chance to approximately 70% accuracy of judgment, neither response was significantly more accurate than the other.

- 307 Duncan-Johnson, C. C., & Coles, M.G.H. Heart rate and disjunctive reaction time: The effects of discrimination requirements. Journal of Experimental Psychology, 1974, 103, 1160-1168.

In three experiments, Ss were given series of easy or difficult auditory discriminations in the context of a fixed foreperiod disjunctive reaction time task. Tonic heart rate was slower during series of difficult trials than during series of easy trials, when they were presented in separate sessions. When they were given in two halves of the same session, this result was not replicated. When easy and difficult trials were presented in a random order, and information was provided at the beginning of the foreperiod about the difficulty of that trial, phasic deceleration was greater on difficult trials. Peak-to-trough change was negatively related to reaction time in all experiments. The results are discussed in terms of Lacey's intake-rejection hypothesis.

- 308 Duncan-Johnson, C. C., & Donchin, E. The effects of the a priori and sequential probability of stimuli on the event-related potential. Psychophysiology, 1977, 14, 95. (Abstract)

We assessed the relative contribution of two determinants of the expectancy of an event to the waveform of the event-related potential (ERP) it elicits. A model developed in this lab (Squires, Wickens, Squires, & Donchin, in press) assumes that the effects of the a priori probability of an event and the sequence of the immediately preceding events add linearly to determine event expectancy. The assessment was done at 9 levels of a priori probability, ranging from .10 to .90 in steps of .10. In separate series, high (1500 Hz) and low (1000 Hz) tones were presented to 10 subjects at each level of probability, both when the train of events was task-relevant and when the subjects were performing an alternate task to which the tones were irrelevant. The EEG was recorded from Fp₂, F₂, C₂, P₂, and O₂.

Visual inspection as well as regression and Principal Components analyses of the average ERPs revealed that the amplitude of the P300 and Slow Wave components was inversely proportional to the a priori probability of a task-relevant event. The lower the a priori probability, the larger the P300 complex. Yet even highly probable stimuli elicited a large P300 if they were immediately preceded by the infrequent stimulus.

To assess the interaction between the effects of a priori and sequential probability, Stepwise Discriminant Analysis was used to obtain specific measures of the P300 complex for all second-order sequences (AA, BA, AB, BB). Discriminant scores decreased as a function of increasing a priori probability for all sequences, but the scores for alternations (BA, AB) were larger than those for repetitions (AA, BB) by a constant amount at each level of a priori probability.

It thus appears that the sequence of stimuli preceding an eliciting event and the a priori probability of stimulus occurrence are additive determinants of the P300 complex.

- 300** Dureman, E. I., & Boden, C. Fatigue in stimulated car driving. Ergonomics, 1972, 15, 299-308.

The aim of this study was to assess the effects of four hours continuous 'driving' in a car simulator on (a) performance (number of steering errors and brake reaction time), (b) subjective fatigue, (c) pulse rate, respiratory rate, skin resistance and neck muscle tension, (d) intra-subject correlations between the latter variables and performance over time. An additional aim was to study these psychological and physiological measures when arousal was stimulated by the pairing of an electric shock with steering errors.

To control training effects the Ss repeated the experiment twice. The results showed that all subjects had a progressive performance decrement over time in parallel with increased feelings of fatigue. There was also a decrease in pulse rate and respiratory rate. Skin resistance showed continuous increment over time. Covariations over time between performance variables and physiological variables were rather high in most individuals; e.g. for pulse rate with frequency of steering errors, and EMG with frequency of steering errors.

The expectation of an electric shock in connection with steering errors yielded higher subjective and autonomic arousal, slower performance decrement over time, and also lowered variability, both within and between subjects for all the variables recorded.

- 310** Durrant, J. D., & Shalloo, J. K. Effects of differing states of attention on acoustic reflex activity and temporary threshold shift. Journal of the Acoustical Society of America, 1969, 46, 907-913.

Temporary threshold shift (TTS) and acoustic reflex activity were observed in 20 normal hearing subjects under several different states of attention. The Zwislocki acoustic bridge (model 3) was used to monitor acoustic reflex activity. Compliance shifts (changes in relative compliance) were measured during exposure of the contralateral ear to a 1000-Hz narrow-band noise presented at 105 dB SPL, and TTS was measured at 1000 Hz for the contralateral ear after approximately 4½ min of noise exposure. These measures were taken under three different conditions or modes of attention as defined by task performance: reverie (no task performance, high auditory attention), intelligibility test, and high visual attention (visual-motor task). Also, levels of attention, as operationally defined by levels of task performance, were considered. From the results of this and other investigations it was concluded that there is a so-called central factor involved in acoustic reflex activity although task performance per se, not type of task, is the important factor. However, such a factor in TTS, if observed, is probably an artifact of the type of task performance of the listener.

- 311 Dustman, R. E., & Beck, E. C. Phase of alpha brain waves, reaction time and visually evoked potentials. Electroencephalography and Clinical Neurophysiology, 1965, 18, 433-440.

A reaction time study was conducted in which twenty subjects were asked to respond to single flashes of light by closing a response switch as quickly as possible. The flashes were presented during six different phase intervals of alpha waves to determine whether reaction times would be related to alpha phase, thus reflecting changes in cortical excitability.

Reaction times were found to be reliably faster when the stimulus light was flashed during certain portions of the alpha wave, thus supporting the hypothesis of an excitability cycle being related to the alpha wave.

Inked plots of the resulting averaged visually evoked potentials yielded a complex wave consisting of eight distinct components in the first 300 msec of the response. Only two of these components correlated positively and significantly with reaction time. The peak delay of the earliest and most highly correlated of the two components was used as a measure for the interval of time required for the volley initiated by the flash to have reached the cortex and the neural integration necessary for "perception" to have occurred. When the alpha phase during which the light was flashed was corrected by this amount (57 msec), fastest mean reaction times were found to fall on a surface negative phase of the wave while the slowest fell on a positive phase.

- 312 Dustman, R. E., & Beck, E. C. Visually evoked potentials: Amplitude changes with age. Science, 1966, 151, 1013-1015.

Visually evoked potentials of 215 subjects, aged 1 month to 81 years, were studied. Amplitudes of waves in the first 250 milliseconds of the response changed markedly with age. In responses recorded from the occiput, there was a rapid increase in amplitude reaching a maximum in the 5- to 6-year-old group, with means of amplitudes at this age being about twice as large as means of some older age groups. With children 7 years and older there was a rapid decline in amplitude until ages 13 to 14, when an abrupt increase in amplitude appeared. Amplitude appeared to stabilize at about age 16. In older subjects, mean age 60 and beyond, significant changes were noted in the earlier components of the response.

- 313 Dustman, R. E., Boswell, R. S., & Porter, P. B. Beta brain waves as an index of alertness. Science, 1962, 137, 533-534.

Reaction times of human subjects are reliably shorter when the signal to respond is given during spontaneous low voltage, fast (beta) brain waves than they are when the signal is given during spontaneous alpha waves. The mean difference of 12 milliseconds is, however, trivial in comparison to the advantage to be expected from forewarning.

E

- 314** Eason, R. G. Relation between effort, tension level, skill, and performance efficiency in a perceptual-motor task. Perceptual and Motor Skills, 1963, 16, 297-317.

The following results were obtained: (1) Neuro-muscular control decreased linearly and tension level exponentially as target area was increased. (2) Neuro-muscular control increased with each day of practice, the amount of increase being inversely related to the size of the target being tracked, while the average daily tension level of each muscle remained essentially constant for each target. (3) Days of practice interacted with target size to affect neuro-muscular control. As target size was decreased, neuro-muscular control increased then decreased on Day 1, increased in a negatively accelerated manner on Days 2 and 3, and in a linear manner on subsequent days. (4) Neck muscle tension alone was found to be as good an indicator of effort as all muscles combined. (5) An inverted U-shaped relationship was obtained between performance efficiency and target size. (6) Between-S comparisons revealed no systematic relationship between neuro-muscular control and tension level, but those Ss manifesting the least degree of control tended to be the least efficient. (7) Neuro-muscular control deteriorated during a continuous tracking period. (8) The slope of the tension level function obtained from neck muscle during continuous tracking was significantly affected by the size of the target being tracked. (9) Except for the smallest target, performance efficiency increased, then decreased, during continuous tracking for 3½ min. There was a progressive decrease in efficiency for the smallest target. (10) The degree of deterioration in neuro-muscular control which occurred during continuous tracking was inversely related to the number of days of tracking experience. (11) During each daily session neuro-muscular control increased from trial to trial while neck tension level decreased.

- 315** Eason, R. G., Beardshall, A., & Jaffee, S. Performance and physiological indicants of activation in a vigilance situation. Perceptual & Motor Skills, 1965, 20, 3-13.

Changes in performance and in 4 physiological measures during a 1-hr vigil and as a function of signal presentation rate were studied. Based on data obtained from 6 Ss during a total of 24 vigils, performance (%correct detections) and skin conductance decreased during the course of a vigil, heart rate remained constant, and neck tension level increased. There was no consistent tendency for Ss to perform at a higher level when signals were presented at a relatively fast rate than when presented at a slower rate. However, their performance was differentially affected by presentation rate. A positive relationship was found between the relative performance level manifested during the 2 rates (fast rate expressed relative to slow) and the relative magnitudes of skin conductance, heart rate, and neck tension level. The results were interpreted as supporting the hypothesis that variations in vigilance performance are in part determined by changes in activation level.

- 316** Eason, R. G., & Branks, J. Effect of level of activation on the quality and efficiency of verbal and motor tasks. Perceptual and Motor Skills, 1963, 16, 525-543.

The primary purpose of the study was to test an implication of Duffy's two-dimensional hypothesis that all behavior varies along two independent continua, direction and intensity. If true, then whether tension level correlates positively or negatively with performance on a given task should be dependent on whether S directs his attention and effort primarily to that task, or whether he shares his attention with some other task situation or set of cues which interferes with performance on the task being measured. Secondary purposes of the study were to gain further information as to which muscles are the most reliable and sensitive indicators of activation level, and to observe the effects of continuous and distributed practice on performance quality, tension level, and performance efficiency. Sixteen Ss performed a rotary tracking (motor) task while simultaneously performing a nonsense-syllable memorization (verbal) task under four incentive conditions. Incentive was varied to manipulate the amount and direction of attention and effort directed to each task. The results provided strong evidence that the relationship between tension level and performance is dependent upon the direction in which S exerts his effort, as well as its intensity. Performance efficiency, expressed as the ratio of performance quality to tension level (EMG), varied with incentive, length of continuous work, and degree of skill. The EMG level of neck muscle was more sensitive to, and changed more consistently with, variations in incentive than did that of any of the other muscles from which recordings were obtained (frontalis, trapezius, and forearm flexors). Frontalis muscle was least sensitive to incentive variations. The results suggest that frontalis muscle tension level is not as good an index of activation level as is that of the neck or of several muscles combined. EMG gradients observed during continuous performance of verbal and motor tasks were interpreted as indicative of a progressive increase in activation level resulting from a change in the psychological significance of the task situation as perceived by S.

- 317** Eason, R. G., & Dudley, L. M. Physiological and behavioral indicants of activation. Psychophysiology, 1970, 7, 223-232.

The present study demonstrates that various central and peripheral physiological variables are similarly altered by experimentally induced changes in activation while being dissimilarly altered during the course of a trial by unknown factors. That is, both general and specific physiological changes are demonstrated in a single experiment. Activation level was experimentally altered by having S: (a) react to light flashes under threat of shock, (b) react to flashes without any such threat, and (c) passively observe light flashes. Evoked cortical potentials, heart rate, skin conductance, and muscular tension were similarly affected by these experimental conditions, but the variables showed differential changes over time. It was concluded that these physiological processes simultaneously reflect both generalized arousal and directionally fractionated activity.

- 318** Eason, R. G., & Dudley, L. M. Effect of stimulus size and retinal locus of stimulation on visually evoked cortical responses and reaction in man. Psychonomic Science, 1971, 23, 345-347.

A study was made of the effects of variations in the size of a circular light flash presented to each of three retinal areas on the averaged evoked cortical response and reaction time. Flashes varying in size from 0.14 to 20.63 deg of visual angle were centered about the fovea and at distances of 20 and 40 deg from the fovea. Evoked response latency and reaction time varied inversely with stimulus size and directly with distance from the fovea. The initial deflection of the evoked response increased with stimulus size for all retinal locations. Later deflections either decreased, showed no change, or first increased, then decreased with increasing stimulus size, depending on retinal locus of stimulation. The results were explained in terms of areal summation and a model of evoked cortical activity which postulates an alpha-like neural process momentarily controlled by an "extrinsic pacemaker."

- 319** Eason, R. G., Harter, M. R., & Storm, W. F. Activation and behavior: I. Relationship between physiological "indicants" of activation and performance during memorization of nonsense syllables using differing induced tension conditions. Perceptual and Motor Skills, 1964, 19, 95-110.

This is the first of a series of studies oriented toward determining what physiological variables constitute the most reliable and valid indices of activation level; what is the minimal number of variables required to estimate accurately general activation level as well as patterns of activation, taking into account the activity of both the autonomic and somatic nervous systems; and how each variable relates to performance under specified conditions. The primary purpose of this study was to ascertain how four different "indicants" of activation level relate to one another and to verbal performance under different induced tension conditions. Sixteen Ss memorized 16 5-syllable lists of 3-letter nonsense syllables under 16 conditions in a single experimental session, using a balanced Latin square to control for order effects. The conditions were generated by various combinations of three independent variables: (1) mode of syllable presentation (visual vs auditory); (2) method of inducing tension (lifting weights vs squeezing hand dynamometer); and (3) amount of induced tension (5, 10, 15, and 20 lbs.). Each trial was 2 min long, being followed by 2 min of rest. Orderly within- and between-trial changes were noted in skin conductance, heart rate, and neck and forearm flexor tension level, but the changes varied, respectively, among the four variables from decreasing to increasing functions. This gradual transition was explained in terms of the relative degree of control the autonomic and somatic nervous systems exerted on each of the variables. The decreasing functions probably reflect a gradual reduction in the degree of anxiety or apprehensiveness experienced by Ss; the increasing functions probably reflect an increase in the amount of muscular effort exerted by Ss in order to maintain a specified amount of force on a hand grip device. Increasing amounts of induced tension caused performance to deteriorate and caused heart rate and forearm flexor tension level to increase. The manner in which the syllables were presented and method of inducing tension significantly affected performance but not the physiological variables.

- 320** Eason, R. G., Harter, M. R., & White, C. T. Effects of attention and arousal on visually evoked cortical potentials and reaction time in man. Physiology and Behavior, 1969, 4, 283-289.

The combined effects of general arousal and specific attention on averaged evoked potentials and reaction time were studied. Arousal level was manipulated by the presence or absence of a shock threat when the flashes were being presented. Attention was varied by having S react to flashes appearing in either his right or left visual field while ignoring flashes appearing concomitantly but not simultaneously in the opposite field. Potentials evoked under "high" arousal (threat of shock) were greater than those obtained under "low" arousal. Also, reaction times were shorter. The potentials evoked by flashes receiving attention were much greater than those evoked by flashes being ignored. The results indicate that cortical evoked potentials are related to both general arousal and specific attention. The combined effects of increasing or decreasing arousal and shifts in attention toward or away from the evoking stimulus determine whether the net change in evoked potential amplitude will be positive or negative.

- 321** Eason, R. G., & Ritchie, G. Effects of stimulus set on early and late components of visually evoked potentials. Paper presented at the 17th annual meeting of the Psychonomic Society, St. Louis, November 1976.

The sensitivity of the earliest discernible deflection (P1), as well as N1, to stimulus relevancy provides further support for the notion that stimulus set involves a neural feedback mechanism which attenuates irrelevant visual information prior to its arrival at primary sensory cortex. Stimulus set appears to involve a neural mechanism whereby some part of the cerebral cortex (perhaps association cortex) indirectly controls the responsiveness of primary visual cortex by exerting a tonic centrifugal influence on sensory information channels at a subcortical level. When an irrelevant stimulus is presented, the tonic neural inhibition generated by stimulus set impedes the flow of information to primary visual cortex, and thus the very earliest components of the evoked response are attenuated. When a relevant stimulus is presented sensory information flow is unimpeded, and a full fledged response occurs at the cortical level.

- 322** Eason, R. G., & White, C. T. Muscular tension, effort, and tracking difficulty: Studies of parameters which affect tension level and performance efficiency. Perceptual and Motor Skills, 1961, 12, 331-372.

The results of these studies tend to support the following generalizations. (a) In highly skilled Ss, whether or not a particular level of tension in a muscle will be beneficial or detrimental to the performance of a perceptual-motor task, or to a mental task for that matter, seems to be dependent on the factors which induced the tension. If, for example, the tension primarily reflects the amount of effort being directed to a particular task, it will probably be beneficial to the performance of that same task. If, however, the tension primarily reflects effort which is being directed to a second task, then it may be detrimental to the performance of the first. An exception to this would be when the second task does not demand enough effort or attention to be distracting, yet the activity associated with it has a stimulating (alerting) effect on the individual and "prepares" him for the first task.

(b) The surface EMG may be potentially useful as a means for monitoring the amount of effort one exerts while performing tasks in field situations such as typing, driving a car, flying a helicopter, or operating any kind of machine. Once the relationships which exist between EMG level and performance at a particular task have been reliably established for a given individual, it may be possible to predict his performance in the immediate future by noting trends in EMG level. Such a predictive device could be extremely useful in applied situations where a decrement in performance might be injurious either to the operator or to others.

- 323** Edwards, B. R. Pupillary size changes during information processing overload. Unpublished master's thesis, Naval Postgraduate School, Monterey, Calif., 1972. (DDC No. AD-743 754)

Pupillary size changes were investigated during a one-bit and two-bit information processing task. For an information processing task, a random list of the digits two and three and a random list of the digits one, two, three, and four were presented visually on a digital readout by means of a paper tape reader for a one-bit and two-bit task, respectively. The subject's required response was to depress a pushbutton switch corresponding to the digit presented on the digital readout. For both the one-bit and two-bit tasks, pupil diameter increased with an increasing information processing rate, reached a maximum at maximum information processing capacity, and rapidly constricted as maximum information processing capacity was exceeded.

- 324** Edwards, D. C. Psychophysiological patterning to psychological processes. Perceptual & Motor Skills, 1968, 26, 405-406.

A further demonstration of differential direction of heart rate change in response to perceptual and cognitive serial tasks in 10 male students supports the findings of previous researchers.

- 325** Edwards, D. C., & Alsip, J. E. Intake-rejection, verbalization, and affect: Effects on heart rate and skin conductance. Psychophysiology, 1969, 6, 6-12.

Visual tasks judged to require stimulus intake or rejection were accompanied by instruction to verbalize or not to verbalize as they were presented to 20 male undergraduates. Heart rate (HR) and skin conductance measures indicated that: (1) J. I. Lacey's directional fractionation occurred to intake stimuli rated pleasant and unpleasant; (2) an instruction to verbalize following the task increased HR within the limits of a supposed ceiling effect, removing evidence of directional fractionation; and (3) there was no direct relationship between the measures and rated affect. Previous conclusions were examined in relation to these findings.

- 326** Edwards, D. C., & Alsip, J. E. Stimulus detection during periods of high and low heart rate. Psychophysiology, 1969, 5, 431-434.

Tested Lacey's suggestion that elevated heart rate (HR) and blood pressure could lead to decreased sensory sensitivity and a reduction in HR and blood pressure may facilitate sensory sensitivity. Ss were 11 male undergraduates. A tone of 5 intensities encompassing Ss intensity threshold was presented randomly 25 times under low transient HR. Results indicate no difference in the number of correct detections under high and low and no interaction between HR level and tone intensity. It is concluded that low HR may well be a necessary condition for increased sensory sensitivity, but that it is not a sufficient condition. Discussion is directed to the range of possible HR changes and the possible requirements of the sensitivity mechanism.

- 327** Elias, M. F. Heart rate, skin potential response, and latency of overt response, as indicators of problem recognition and solution. Psychonomic Science, 1970, 18, 337-339.

Studied heart rate, skin potential, and response latency in relation to the recognition and solution of problems by 18 high-school students. A continuous series of rule-induction problems was presented without any pause between problems. The problems were sequentially related in that each new problem demanded a refinement of the rule just induced for the preceding problem. Increases in skin potential and response latency occurred when new problems were introduced, and decreases in the same measures were found when they were solved. Heart rate was not indicative of recognition or solution of problems. When events during trials - stimulus, response, feedback - were looked at separately, the events of stimulus onset and response were associated with significant increases at recognition. Only the feedback event was associated with a significant decrease at solution. It is suggested that these changes indicate a labile state during which problem solving occurs.

- 328** Elliott, R. Physiological activity and performance: A comparison of kindergarten children with young adults. Psychological Monographs: General and Applied. 1964, 78, (10, Whole No. 587)

Twenty-one young adults and 41 kindergarten children performed repeated blocks of trials of simple auditory reaction time (RT), sometimes for incentives, sometimes not, while EEG and other physiological responses were recorded. Children differed from adults in that they manifested: (a) no covariation between quality of performance and level of physiological activity; (b) far lower intra-individual correlations between one physiological response and another; (c) no adaptation over the session; (d) far weaker relations between preparatory (interstimulus) intervals and RT; and (e) increases, rather than decreases, in the amplitudes of the various EEG frequencies with increasing motivation and physiological activity. These differences were considered in the light of certain important similarities in response between the children and various groups of adults.

- 329** Elliott, R. Reaction time and heart rate as functions of magnitude of incentive and probability of success: A replication and extension. Journal of Experimental Research in Personality, 1966, 1, 174-178.

A modification and replication of a previous study on the effects of probability of success (PS) and magnitude of incentive (MI) upon heart rate (HR) and reaction time (RT) makes possible the following conclusions: The method of establishing PS is flexible, accurate, and convincing to S; effects of MI and PS were very weak on HR; they were significant on RT, changing in nature over the ten experimental days; and no lawful relation existed between RT and HR.

- 330 Elliott, R. Tonic heart rate: Experiments on the effects of collative variables lead to a hypothesis about its motivational significance. Journal of Personality and Social Psychology, 1969, 12, 211-228.

Five experiments assessed the effects of conflict and uncertainty on tonic heart rate (HR) in a variety of situations, including comparisons of having versus not having control over an escape response from shock, making easy versus hard tone discriminations, naming colors or reading names of colors versus naming the hue of an incompatible color-word (Stroop test), and performing in a reaction-time task with predictable versus unpredictable preparatory intervals. These collative variables either had no effect on tonic HR or they had an effect (deceleratory) opposite to expectations; but response factors and incentive factors had strong accelerating effects. A hypothesis is stated to the effect that under the usual boundary conditions of the psychological experiment, the critical features controlling tonic HR acceleration are the instigation, anticipation, and initiation of responses, and the presence of incentives. Studies are reviewed in which "emotionality" was present but in which no rise in tonic HR occurred unless either of the two features was present. Other studies are reviewed in which both HR and palmar conductance (PC) were used, and a hypothesis about the difference in their motivational significance is suggested.

- 331 Elliott, R. The significance of heart rate for behavior: A critique of Lacey's hypothesis. Journal of Personality and Social Psychology, 1972, 22, 398-409.

Lacey's hypothesis concerning cardiovascular feedback effects on attention is presented. Relatively direct tests of the hypothesis seem not to support it well. Its terms appear to lack sufficient independent definition to permit discriminating interpretive use. An alternative is to view heart rate change, like change in motor behavior, as a response, and one hypothesis that does that, chiefly identified with the work of Obrist, is presented for illustration and contrast with respect to measurability, definition, and parsimony.

- 332 Elliott, R. Further comment on the Lacey hypothesis. Journal of Personality & Social Psychology, 1974, 30, 19-23.

Responds to reply by J. I. Lacey and B. C. Lacey to original criticism of their hypothesis of heart rate behavior. The main theoretical and empirical issues are again drawn. Some of the Laceys' assertions are denied, and some of their charges answered. The considerations and arguments advanced by the Laceys in their reply are not sufficient to warrant any change in the conclusions of the original critique [Article also reviews the relationship between heart rate and attention].

- 333 Elliott, R. The motivational significance of heart rate. In: P. A. Obrist, A. H. Black, J. Brener & L. V. DiCara (Eds.), Cardiovascular psychophysiology: Current issues in response mechanisms, biofeedback, and methodology. Chicago: Aldine, 1974.

To be sure of this independence of deceleration and speed, we assessed the RTs accompanying the largest and smallest HR deceleration in each condition: e.g., 4-second, random, low incentive; 4-second, fixed, low incentive, and so on. In each major group there were, thus, 10 comparisons for each S. Of the 20 dependent t-tests, only two were significant, but these were in opposite directions. It would be difficult to argue from these data that deceleration had much to do with performance.

There are in these data, in short, grounds for skepticism about any view of the motivational significance of HR. The data at the phasic level are compatible enough with the cardiac-somatic view. And the difficulties at the tonic level may be primarily a problem of restriction of range and error of measurement. That is, the average excursion of HR and movement measures in the phasic intervals was greater than in the tonic intervals, except in the one instance - comparing the ordinary rest periods with the "quiet" condition - in which the tonic measures covaried quite well. And, of course, we cannot say we have sampled somatic activity adequately. But I would feel more content if we had produced large incentive shifts in HR.

In the meantime, and as a conclusion, it may be worth considering that the cardiac-somatic hypothesis, to the degree that it is sound and comprehensive, makes HR changes relatively uninteresting to the psychologist. If HR does, as Obrist *et al.* (1972a) have suggested "provide in one muscle a picture of the total somatic involvement at any given time," it is a picture too simple for use by most psychologists (although to check whether one's S is resting during rest, or generally involved during tasks, a summary index would be useful). The heart has few direct effects on the environment, and it is not the totality, but the particularity of striate muscle activity that most of us are concerned with most of the time. If HR is not, in short, a good index of classically conditioned effects and motivational-emotional effects, independent of somatic effects, much of our interest in it will diminish. For me, that is all the more reason to test the limits of the cardiac-somatic hypothesis.

- 334 Elliott, R., & Graf, V. Visual sensitivity as a function of phase of cardiac cycle. Psychophysiology, 1972, 9, 357-361.

After preliminary threshold determination, each of 25 Ss was given 120 trials (24 blank, 96 signal) in a visual signal detection task, with signal presentation being recorded with S's EKG. There was no relationship between hit rate and phase of cardiac cycle whether assessed over four measured phases, or as the difference in hit rate for signals presented either in the P-wave or the QRS complex. Implications for theory are discussed.

- 336** Ellis, R. R. The CNV phenomenon and selective attention. Electroencephalography and Clinical Neurophysiology, 1969, 27, 664. (Abstract)

The CNV was first developed or extinguished to the "cue stimulus". Each subject served as his own control and order of CNV presence or absence was counter-balanced. In 1/3 of the subsequent trials one of the 3 "test stimuli" was superimposed upon the "cue stimulus" 500 msec after the onset of the "cue stimulus".

A significant ($P < 0.05$) increase in amplitude of a surface positive vertex wave approximately 180 msec following the "test stimulus" occurred during the presence of the CNV as compared with its absence for the group in which the test stimulus was a 500 c/sec tone of increased intensity. No significant changes in vertex responses were found in the other 2 groups.

The fact that the ER change is specific only to the "test stimulus" of identical quality to the "cue stimulus" is consistent with a selective attention process and inconsistent with predictions derived from general arousal or response mobilization hypotheses.

- 336** Ellis, R. R. Attention, intention, and the contingent negative variation phenomenon (Doctoral dissertation, University of Nebraska, 1970). Dissertation Abstracts International, 1971, 31, 5018B. (University Microfilms No. 71-2882)

Two experiments aimed at elucidating the relations between attention, intention and the Contingent Negative Variation phenomenon, were done. One experiment deals with the relationship between the CNV and selective attention. High and low CNV amplitude was the independent variable. The CNV was manipulated by having the S press or not press a thumb switch at the offset of a 500 Hz 36 db tone of 1000 msec duration (the "cue stimulus"). A "test stimulus" was superimposed on cue presentations. There were 3 dependent variables: (1) amplitude of a late component of the vertex potential changes evoked by the "test stimulus", (2) a rating scale of attention to the cue stimulus, and (3) response speed to the offset of the cue stimulus. Eighteen male university students were assigned to 3 groups who received test stimuli, differing from the "cue stimulus" on dimensions of: (1) intensity, (2) quality (frequency), or (3) modality (visual flash). It is concluded that the EP and response speed data converge on the explanation that the CNV is related to selective attention. The purpose of the second experiment was to demonstrate a relationship between the CNV phenomenon and the intensive aspects of attention and intention. The CNV was developed by presenting a 500 Hz 36 db 100 msec tone (S_1) followed 1000 msec later by the onset of a complex visual stimulus (S_2) to which the S made a response. S_2 remained exposed until 500 msec after the responses. Two levels of attention were produced by presenting focused and unfocused slides (S_2). Intention was manipulated by requiring the S to press a switch which offered 3 markedly different degrees of resistance to switch movement. Data were obtained from each of 12 university students under all combinations of attention and intention conditions. The response latency and the questionnaire data led to the conclusion that intention and attention had been varied. The amplitude of the CNV was found to be significantly larger, during S_2 presentation, when the pictures were focused than when they were blurred. No other differences occurred. It was concluded that only the intensive aspect of attention is reflected in the CNV measure.

It was suggested that intensive attention might be intimately related to selective attention as well as the environment as a whole.

- 337** Elul, R. Gaussian behavior of the electroencephalogram: Changes during performance of mental task. Science, 1969, 164, 328-331.

The probability distribution of the amplitude of scalp electroencephalogram has been investigated in an adult subject in the idle state, and during performance of a mental arithmetic task. Based on a large sample, the electroencephalogram in this subject in the idle state follows a Gaussian (normal) probability function 66 percent of the time. During performance of the arithmetic task, the portion of Gaussian electroencephalogram decreases to 32 percent. The probability function characterizing gross electroencephalographic activity is determined by the degree of mutual interaction of individual cellular generators and wave activity in the tissue underneath the recording electrode. The data imply an increase in the cooperative activity of cortical neuronal elements during performance of a mental task.

- 338** Engel, B. T., Thorne, P. R., & Quilter, R. E. On the relationships among sex, age response mode, cardiac cycle phase, breathing cycle phase, and simple reaction time. Journal of Gerontology, 1972, 27, 456-460.

The findings in this study are essentially negative. They are:

There is no evidence of any significant tendency of individuals or groups to emit RTs which are in any way determined by the electrical events of the cardiac cycle.

RTs tend to be longer during expiration than during inspiration; however, this effect is most likely attributable to coincident differences in foreperiod (preparatory interval) duration rather than to breathing cycle per se.

Men between the ages of 55 and 65 years do not necessarily emit RTs which are slower than men between 20 and 30 years. The differences between comparably aged women are significant; however, the differences cannot be exclusively attributed to chronological age or to sex (since 20- to 30-year old women are no slower than 20- to 30-year-old men).

When other factors are controlled, response mode, i.e., key-press vs. key-release, has no effect on RT.

These results show that there is no relationship between RT and phase of the cardiac cycle, phase of the breathing cycle, or age under conditions of this study. Although we controlled a number of variables, it is possible that other factors which we did not control may mediate any of these relationships. In subsequent studies we plan to investigate the effect of such factors as fatigue and inter-trial interval on RT.

- 339** Engel, P., & Hilderbrandt, G. Über den Einfluss der Vigilanz auf die Phasenkoppelung zwischen Herzschlag und Atmung. [The influence of vigilance on the phase coupling between heart beat and respiration.] Psychologische Beiträge, 1973, 15, 77-86.

Conducted an experiment with 22 male and 10 female 19-41 yr old healthy Ss to examine the phase coupling between heart beat and respiration as an indicator of the level of vigilance. Es measured the reaction time to an acoustic signal, the rate of phase coupling between heart beat and inspiration start before and after the administration of caffeine. Measurements were taken by the automatic coincidence measuring instrument Synchromet in about 2/3 of the Ss and by way of continuous synchronous EKG registration in the rest. Both methods recorded the elapsed time between the preceding R-peak and the thermoelectrically established start of inspiration. Results show that caffeine effected a parallel decrease in reaction time and coupling rate but no specific modifications in the distribution pattern of inspiration starts within the cardiac cycle. It is concluded that measuring the rate of phase coupling (a) does not place any special performance requirements on Ss and thus does not influence vigilance itself and (b) therefore it appears to be a valid method of judging the level of vigilance.

- 340** Epstein, S., Boudreau, L., & Kling, S. Magnitude of the heart rate and electrodermal response as a function of stimulus input, motor output, and their interaction. Psychophysiology, 1975, 12, 15-24.

In Part I, 20 Ss squeezed a dynamometer at various levels of capacity. Heart rate and skin conductance were monitored during the anticipatory period and during each squeeze. In Part II, reactivity to the four combinations of the presence and absence of a loud noise and the presence and absence of a strong squeeze was examined. Part III compared reactivity to the loud noise under the following conditions: as an unfamiliar, surprise stimulus; as a familiar, surprise stimulus; as a familiar, expected stimulus. Major conclusions were: (1) Heart rate varies more directly and reliably with motor output than skin conductance; (2) Skin conductance is more sensitive to small cognitive than to small motor effects; (3) Skin conductance is more reactive to stimulus input than to motor output, while the opposite is true for heart rate; (4) A strong familiar stimulus presented by surprise elicits a marked heart rate decelerative reaction, usually, but not always, preceded by a smaller accelerative reaction; (5) Baseline changes immediately preceding stimulus onset markedly affect the response to stimulation, and can account for the attenuated reactions observed when a noxious stimulus is preceded by a warning signal.

- 341** Ettema, J. H. Blood pressure changes during mental load experiments in man. Psychotherapy and Psychosomatics, 1969, 17, 191-195.

Several experiments are discussed showing an increase in systolic and diastolic blood pressure as a function of the amount of information handling per time unit.

In short-term experiments, this rise in blood pressure is not very impressive and remains within the normal physiological range. There are some indications, however, that prolonged intensive mental load induces a more important increase in blood pressure.

Increase in blood pressure, together with changes in other physiological phenomena such as heart rate, sinus arrhythmia, etc., indicate that mental load may alter the level of activity of the autonomic nervous system.

In the experiments, an auditive binary choice task (high or low tone in random sequence and of differing frequency to be answered by pressing a right or a left pedal) was used to evoke mental load.

- 342** Ettema, J. H., & Zielhuis, R. L. Physiological parameters of mental load. Ergonomics, 1971, 14, 137-144.

Discusses the essential aspects of the terms "load" and "capacity" as used in work physiology, as being valid for mental load in the following ways: (a) the question of the physiological costs (biological consequences) of a given performance; (b) external load to be measured in units of performance/time (signals/time, choices/time); (c) capacity, dependent on time of endurance; (d) physiological changes correlating with load; and (e) pathological symptoms due to extreme load. An experiment with 24 20-25 yr. old students is discussed, where a simple binary choice task is used with several frequencies of signals to be answered, thus providing different loads. Systematic changes were found in heart frequency, sinus arrhythmia, systolic and diastolic blood pressure, rate of respiration, etc. It is suggested that these changes are due to a simultaneous rise in sympathetic and in vagal tone.

- 343** Evans, C. R., & Mulholland, T. B. Attention as a concept in neurophysiology. Science, 1969, 163, 495-496.

Reviews findings of a conference on neurophysiological aspects of the psychological concept of attention. Issues examined include: (a) relation of visual control systems to EEG occipital alpha rhythm, (b) evoked responses, (c) the role of the reticular activating system in the acquisition of CRs, and (d) habituation of response from single cells in brain and behavioral reactions.

- 344** Evans, C. R., & Smith, G. K. Alpha-frequency of electroencephalogram and a stabilized retinal image. Nature, London, 1964, 204, 303-304.

It therefore seems evident that the suppression of alpha is related to the presence of a pattern in the visual field. How closely this is linked to 'attention' phenomena is not clear, though it should be mentioned that the key pressing task, which might conceivably be expected to inhibit alpha somewhat was deliberately confined to the basic experimental condition (that is, the subject pressed the key when the target was absent). (In fact, pilot investigations had indicated that the muscular act of random key-pressing did not seem to affect alpha in any obvious way. Typically in the experimental sessions, the key was depressed only four or five times in a 4-min run.) The role of 'attention' in relation to pattern perception cannot, of course, be established from a preliminary investigation of this kind. Nevertheless, since the subjects' eyes remained closed in all three conditions of the experiment, and since in all conditions the visual input did not change after the single initial flash, it now seems to be certainly established, perhaps for the first time, that neither of these two variables plays a vital part in the promotion or suppression of alpha. Rather, the independent importance of signals that define contours, boundaries and possibly 'shape' seems to be demonstrated.

- 345** Evans, J. F. Resting heart rate and the effects of an incentive. Psychonomic Science, 1972, 26, 99-100.

One purpose of this study was to determine whether an incentive such as competition would cause increments in the performance of Ss with low resting heart rates and decrements in the performance of Ss with high resting heart rates. Another purpose of the study was to investigate further the hypothesis that an increase in incentive is accompanied by an increase in heart rate. The results supported the hypothesis that an increase in incentive is accompanied by an increase in heart rate and also indicated that the relationship between incentive and heart rate is not affected by resting heart rate level. No performance differences were found.

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- 340** Fagerstrom, K. O., & Lisper, H. O. Effects of listening to car radio, experience, and personality of the driver on subsidiary reaction time and heart rate in a long-term driving task. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

An attempt to counteract performance decrement in long-term car driving was undertaken. Twelve subjects drove 4 hours in each of the three conditions, music, talk, and a silent control condition. Reaction time and heart-rate were recorded during driving. There was a significant main effect of stimulation on time on task and significant interactions between time on task and personality (Eysenck Personality Inventory) and drivers experience. Extroverts benefited more from stimulation than introverts, and inexperienced subjects benefited more from stimulation than experienced. Heart-rate had no functional connection to either of the above mentioned factors. The results are explained in the framework of an arousal theory and contrasted to a fatigue interpretation.

- 347** Fedio, P., Mirsky, A. F., Smith, W. J., & Parry, D. Reaction time and EEG activation in normal and schizophrenic subjects. Electroencephalography and Clinical Neurophysiology, 1961, 13, 923-926.

1. Normal and schizophrenic subjects of similar age and I. Q. were compared on a series of reaction time tasks.

2. EEG from scalp electrodes was monitored during the testing and served to determine when stimuli were presented to the subject.

3. Although the groups did not differ in speed of reaction when alpha activity was present, the normal subjects improved when alpha was blocked by an alerting stimulus while the schizophrenics failed to improve or even performed more slowly.

4. The relationship between behavioral and electrographic measures of arousal, and the possible significance of the findings were discussed.

- 348** Fedor, J. H., & Russell, R. W. Gastrointestinal reactions to response-contingent stimulation. Psychological Reports, 1965, 16, 93-113.

Nineteen student volunteers served as Ss in a research design based upon the use of each S as his own control. Continuous electrophysiological recordings of gastrointestinal activity were taken from surface electrodes on the abdomen of each S during an initial 15-min rest period and an immediately subsequent 25-min task period. During the task period S could avoid an aversive auditory stimulus if he pressed a key at the proper time intervals; the task was sufficiently difficult that successful avoidances for different Ss ranged from an over-all 16% to 72% with a mean of 44% for the group as a whole. The resulting data made it possible to analyze the differential reactions of the gastrointestinal system on successful and unsuccessful trials when the occurrence of the aversive stimulation was always response-contingent, i.e., under the potential control of S. Three parameters of the electrophysiological manifestations of gastrointestinal activity were studied: amplitude, displacement, and peak response time.

- 349** Feigenberg, I. M., & Ivannikov, V. A. Vzaimootnoshenie uslovnoi i orientirovochnoi reaktsii. [The relationship between the conditioned and the orienting responses.] Voprosy Psikhologii, 1969, 15, 39-47.

Analysis of response in disjunctive RT experiments and of associated EEG and EMG recordings lead to the conclusion that the orienting responses and CRs mark the ends of the same continuum. When the stimulus situation is uncertain, the orienting response is strong; when uncertainty decreases, as in the course of repeated UCS-CS presentations, the orienting response decreases and the CR grows stronger. The latter is a response to a situation of high predictability.

- 350** Fenwick, P. B. C., & Walker, S. The effect of eye position on the alpha rhythm. In C. R. Evans & T. G. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

This effect is difficult to explain in terms of current physiological theories about the generation of the alpha rhythm and present neurophysiological concepts of attention. It would be expected that the effort and concentration required to maintain the eyes in the extreme position would effectively block the alpha rhythm. The paradoxical effect which has been described contradicts this. A possible explanation is that the induced alpha rhythm only occurs when visual information is limited, as for example, on closing the eyes. This, however, will not explain the present result, because it can be shown that the alpha rhythm can still be evoked in the absence of visual information, as when the eyes are closed, or when the eyes are open in a completely darkened room. Added to this there is the evidence that the induced alpha rhythm remains unaltered when the eyes are open and the subject is reading a card or scanning a visual after-image.

A tentative model can be suggested which uses the old idea of a pool of cortical cells which, when synchronized, produce the alpha rhythm as measured on the scalp. This pool can however be modified by several factors, some of which are central. Using this model, the concept of attention would be a centrally acting influence. Eye position has now to be added to this list, and the suggestion is that in extreme eye positions in some subjects, the central pool of neurones becomes free and synchronizes to produce an alpha rhythm. This could occur for two reasons. Firstly, because the act of maintaining the eyes in the extreme position causes a shift of attention from the visual field, or secondly, because the act itself in some way causes a modification of the central neurone pool. This phenomenon underlines our lack of understanding of the mechanisms responsible for the generation of the alpha rhythm and suggests as Mulholland and Evans have done that there is considerable danger in using the alpha rhythm indiscriminately as a measure of the psychological state of an experimental subject.

- 351** Fenz, W. D., & Graig, J. G. Autonomic arousal and performance during sixty hours of sleep deprivation. Perceptual and Motor Skills, 1972, 34, 543-553.

The paper reports the performance on 6 tests of the battery used by Reitan designed to evaluate brain dysfunction, as well as autonomic arousal measured by heart rate and basal skin conductance, for 12 Ss during 60 hr of sleep deprivation. Twelve control Ss were tested at equal intervals without sleep loss. The performance on the psychological tests remained unimpaired during the early phases of sleep loss while heart rate and skin conductance increased; the deficit in performance became evident in the last phase of the deprivation period when heart rate and skin conductance declined.

- 352** Fernandez-Guardiola, A., Ayala, F., & Kornhauser, S. EEG, heart rate and reaction time in humans: Effect of variable vs. fixed interval repetitive stimuli. Physiology and Behavior, 1968, 3, 231-240.

Visual motor reaction time (RT) change was measured in 12 normal adults exposed to iterative, prolonged, photic stimulation of two kinds: (a) isochronous (IS) and (b) stochastic (SS). EEG, EKG, eye and palpebral movements were continuously recorded. The mean RT for all subjects was shorter for the IS situation. Stochastic stimulation produced an increase in RT variability. A facilitation of the monitoring task performance during the first 2 min of IS stimulation was observed. It was found that monitoring task performance was positively correlated with the amount of alpha rhythm in the EEG record. A "predictive", brief, attenuation of alpha rhythm appeared when the subject's monitoring task was maintained at a good performance level. It is assumed that this is a sign of expectancy. Deterioration of the monitoring task performance was accompanied by a decrement of the EEG photic driving response and slowing of heart rate. These results are discussed in relation to sensory habituation and to the internal appreciation of time.

- 353** Fiorentini, A., & Maffei, L. Electrophysiological evidence for binocular disparity detectors in human visual system. Science, 1970, 169, 208-209.

Evoked potentials have been recorded from humans in response to two moving gratings presented stereoscopically to both eyes. The amplitude of the evoked potential is greater when the two gratings have slightly different spatial frequencies, which produces an apparent inclination of the binocularly fused image. The amplitude of the response is correlated with the degree of the perceived inclination.

- 354** Firth, P. A. Psychological factors influencing the relationship between cardiac arrhythmia and mental load. Ergonomics, 1973, 16, 5-16.

Examines the development and use of cardiac arrhythmia as an index of mental workload in terms of the relevance of autonomic response to the measurement of task difficulty and the implications of general principles of psychophysiology to the application of cardiac arrhythmia as an applied measure. In addition, the complexity of the psychological factors which may influence task difficulty is discussed with particular reference to second-by-second changes in heart rate variability. It is suggested that (a) the usefulness of global concepts of task difficulty (e.g., mental load) may be questionable; and (b) a greater understanding of what a task entails, with reference to increased psychophysiological knowledge, is necessary in order that global changes in cardiac arrhythmia may be interpreted in relation to task difficulty.

355 Fischgold, H., & Schwartz, B. A. A clinical, electroencephalographic and polygraphic study of sleep in the human adult. In G. E. W. Wolstenholme & M. O'Connor (Eds.), The nature of sleep. Boston: Little, Brown, 1960.

(1) Human adult sleep is studied here by means of EEG and by as varied polygraphy as is possible.

(2) Simultaneous recordings of a sensory stimulus (light), of a motor response (agreed between observer and subject), and of the EEG have made it possible to appraise the "conscious presence" of the sleeper, or the "loss of contact" with the outer world. A temporary sensory-motor link is thus used as a test for the study of wakefulness and sleep.

(3) The sensory-motor link is lost and instructions are no longer carried out during Loomis's stage C (Loomis, Harvey and Hobart, 1937); the sensory afferent stimulation is therefore divested of its previously-learned significance during this stage of sleep.

(4) The possibility of a motor response, the persistence of the learnt sensory-motor link, is accompanied by alpha activity as a background rhythm or a form of reactivity. The significant afferent impulses are therefore positively correlated with the alpha waves.

(5) EEG reactivity of the K complex on "pointe au vertex" type persists after the motor response has disappeared. These reactivity patterns, unlike alpha waves, do not contribute to the carrying out of the instructions learnt, but reflect, rather, the arrival in the brain of the neutral afferent impulses.

(6) A "second degree" vigilance therefore exists during the state of falling asleep (Held, 1960) (stages A, B and sometimes C), a vigilance which ensures contact possibilities between the sleeper and the outside world.

(7) In view of the fluctuations of wakefulness, body movements and the tonus of the various muscular sectors are differentiated. It is now difficult to consider muscular facilitation or inhibition as global manifestation: a spatial, temporal and qualitative differentiation must be made; the centres regulating motricity seem to be particularly complex.

(8) Finally, the problem of the quantitative expression of the EEG sleep data obtained by frequency analysis and integration methods is mentioned.

- 356** Fishbein, E., Pampu, E., Popescu, I., & Koflen, M. Aspecte electroencefalografice ale aplicarii probei mixte de determinare a oboselii intelectuale. [Some EEG aspects obtained by a joint test to demonstrate intellectual fatigue.] Revista de Psihologie, 1965, 11, 375-386.

In applying a joint test under laboratory conditions (utilized by us in the past, but under nonexperimental work conditions: school, professional activity), we obtained a new verification of the following, including the hypothesis upon which it is based: tracing intellectual fatigue is achieved in particular by tracing variations of a secondary peripheral element of the activity, the process of compensation consisting of concentration of efforts in the principal direction of the activity. EEG recording done immediately before and after applying the joint test brought in evidence, in particular, a decrease in alpha index (both following three hours of work and upon application of the test itself), somewhat of an increase in the alpha rhythm amplitude, and the occurrence in some persons of a theta wave. EEG recording done immediately after completing an intensive intellectual activity denotes a probable increase in cerebral excitability.

The joint test used by us, although of short duration, causes an effect of the same type as that caused by a prolonged intellectual task.

- 357** Fitzgerald, H. E., & Allen, T. W. Effects of circadian rhythms on autonomic functioning and its relationship with performance. Psychophysiology, 1977, 14, 93. (Abstract)

The effects of biological rhythms on the relationship between autonomic functioning and performance have been the subject of recent research. Although some studies have shown circadian changes in heart rate (HR) activity, the relationship between HR activity during various phases of the circadian cycle and performance has not been examined. The purpose of the present study was to investigate changes in HR activity, performance, and their relationship during selected phases of the circadian cycle. Twenty subjects were assigned to each of the following conditions: a) a pre-low HR activity group, b) a low HR activity group, and c) a post-low HR group. Ten subjects were tested using a simple reaction time (RT) task with a fixed warning interval. The remaining subjects were tested using a RT task with a variable warning interval. Dependent variables were RT, magnitude of HR deceleration, and HR variance (HRV). Subjects in the low HR activity group produced the slowest RTs while subjects in the post-low HR activity group produced the fastest RTs. Magnitude of HR deceleration and HRV was smallest for subjects in the low HR activity group while largest for subjects in the post-HR activity group. A significant relationship was found between the deceleration and variability aspects of HR activity and RT performance for subjects in the low and post-low HR activity groups only. The findings indicate that circadian rhythms should be viewed as providing a physiological context which interacts to influence the nature and magnitude of phasic and tonic autonomic activity.

- 358** Fitzgerald, H. E., & Porges, S. W. Cardiovascular effects of paced respiration and selective attention. Psychonomic Science, 1970, 19, 65-66.

Investigated the effects of paced respiration (PR) and attentive observation (ATT) on heart rate (HR) and finger-pulse amplitude (FPA) in 16 female undergraduates. Although HR responses to trial onset were task dependent, accelerating for Group PR and decelerating for Group ATT, temporally conditioned anticipatory HR deceleration was obtained across tasks. Across trials, HR decelerated and FPA dilated, indicating autonomic habituation to the experimental conditions. Methodological implications for paced respiration research and FPA analysis are discussed.

- 359 Fjeld, S. P. Motor response and muscle action potential in the measurement of sensory threshold. Psychophysiology, 1965, 1, 277-281.

There was a significant improvement in the accuracy of detection of visual stimuli at or below Ss' thresholds when detection was measured overtly by gross muscle movement responses and covertly by muscle action potential (MAP responses, as opposed to overt responses alone). In addition to yielding a lower threshold value for the series of light stimuli, the MAP measures became more useful as an indicator of accuracy at the weaker rather than the brighter light values, whereas the overt response measures became relatively less useful. These results suggest that events of which the S is "unaware" (covert responses) can convey information about performance to an E, provided suitable methods of measurement can be devised.

- 360 Flanagan, J. Galvanic skin response: Emotion or attention. Proceedings of the 75th Annual Convention of the American Psychological Association, 1967, 2, 7-8. (Summary)

Present results indicate that the concept of attention is a better intervening variable interpretation of GSR than is the concept of emotion. Experienced GSR researchers have repeatedly indicated this conclusion. However, those interested in personality have continued to interpret GSR as an index of emotion or anxiety. One thing that the GSR cannot indicate is continued strong emotion or anxiety because if adrenalin is involved, the GSR is suppressed! The distinction is also of importance to experimental designs because the accidental variables that are relevant to attention (i.e., novelty, suddenness, expectancy, etc.) are typically ignored by experimenters who regard the GSR as an index of emotion or anxiety.

- 361 Flexman, J. E. Respiration as a source of intra-subject variation in simple information processing tasks (Doctoral dissertation, Texas Christian University, 1974). Dissertation Abstracts International, 1974, 35, 2461B. (University Microfilms No. 74-25, 572)

The purpose of the present research was to examine the relationship between respiratory phase and two levels of information processing.

In the first experiment, pneumographic respiratory records were collected from 10 female Ss during visual and auditory detection tasks. The results revealed that in both tasks Ss detected more threshold level signals presented during the exhalation phase of respiration than during the inhalation. Reaction times, however, were not related to the phase of respiration.

Respiratory records were also obtained in the second experiment during a slightly more complex information processing task in which Posner's (1964) paradigm for classification of letters was utilized in a physical match task and a name match task. Ten female Ss performed each task and the results suggested that respiration phase was not related to this type of information processing. However, the results supported the information processing model suggested by Posner and Mitchell (1967) and extended it to include word classifications.

The respiratory records in both experiments were further scrutinized in an exploratory manner to examine the consistency of the six respiratory measures over trials and their relationships with task performance measures such as detection probabilities and reaction times. These results indicated that the respiration measures tended to be stable over trials and tasks, but their relationship to performance measures was unreliable. Suggestions for future research were discussed.

- 362** Florek, H. Spontaneous palpebral reaction in a prolonged visual task. Studia Psychologica, 1972, 14, 313-315.

Reports results of a repeated experiment relating to visual fatigue which lasted 120 min and involved 20 Ss aged 22 yrs. Ss showed a slight increase in the spontaneous eyelid frequency, thus pointing to the onset of visual fatigue. The heart rate showed a decreasing trend, although it appeared to be more sensitive to a change of situation. Quantitative measures of fatigue-inducing factors (i.e., performance and its quality) failed to confirm symptoms of visual fatigue. It is concluded that the results were conditioned by learning or by an incomplete manifestation of the characteristics of the work curve.

- 363** Floru, R., Ciofu, I., Gulian, E., & Cioata, E. Contributii la studiul mecanismelor neurofiziologice ale atentiei: I. Efectele stimularii sistemelor activatoare asupra potentialelor fotice. [Contributions to the study of the neurophysiological mechanisms of attention: I. The effects of stimulation of the activating system upon photic potentials.] Revista de Psihologie, 1964, 10, 243-255.

We studied the relationships between attention and perceptual integration, using as the EEG indicator, the reproduction of luminous intermittent stimulation rhythm (ILS) when involuntary and voluntary attention was stressed (sensory stimulations, memory tests, mental calculations, etc.).

The optimal functional level is bioelectrically expressed by appropriation of the ILS rhythm. Decrement of this level reduces the capability of the structures investigated to reproduce the rhythm imposed. Moderate stress upon voluntary and involuntary attention facilitates the photic potential reproduction; excessive stress upon the activating mechanisms has an inhibitory effect upon the bioelectric indicators.

- 364** Floru, R., Ciofu, I., Gulian, E., & Cioata, E. Contribution a l'etude des mecanismes neurophysiologiques de l'attention. I. Les effets de la stimulation des systemes activateurs sur les potentiels photiques. [A contribution to the study of neurophysiological mechanisms and attention. I. Effects of stimulation of activating systems on photic potentials.] Revue Roumaine des Sciences Sociales Serie de Psychologie, 1964, 8, 35-46.

The study purports to observe the influence of attention on perceptual integration. Towards this purpose 19 adults were subjected to EEG, electrodermograms and electromyogram tests, intermittent light stimulation prior to acoustic stimulation, while awake or in a state of light sleep. It was concluded that (1) the state of optimal excitability, the waking state, when attention is directed to the sensory stimulus, is expressed bioelectrically by an increased intermittent light stimulation rhythm against a background of moderate activation. (2) The decrease in functional level during the waking state, a decrease which is not pronounced during the transition from the waking state to sleep, reduces the capacity of cerebral structures to reproduce the rhythm of the intermittent light stimulus. (3) Excessive stimulation of activity mechanisms causes a decrease of photic potentials.

- 365** Floru, R., Ciofu, I., Gulian, E., & Cioata, E. Cercetari experimentale asupra psihofiziologiei atentiei. [Experimental research in the psychophysiology of attention.] Revista de Psihologie, 1966, 12, 181-197.

An investigation was conducted of the bioelectric changes (e.g., EEG, EMG) during the process of voluntary and involuntary attention in facilitation of optimal excitation by a specific stimulus or complex of stimuli and in the adjustment of intellectual tasks. Solicitation of attention facilitates the segregation in time and space of light potentials by elaborating selective attention. Attention is defined as a psychological process producing an autofacilitation of nervous structures included in sensorial, motor, and intellectual activities.

- 366** Ford, J. M., Roth, W. T., Dirks, S. J., & Kopell, B. S. Evoked potential correlates of signal recognition between and within modalities. Science, 1973, 181, 465-466.

Electrical responses evoked by clicks, flashes, changes in noise level, and changes in light level were recorded from the scalps of human subjects set to detect one of the stimuli. An early negative component of the evoked responses reflects selection between sensory modalities, whereas the later positive component reflects a more complex intramodal discrimination.

- 367** Ford, J. M., Roth, W. T., & Kopell, B. S. Attention effects on auditory evoked potentials to infrequent events. Biological Psychology, 1976, 4, 65-77.

In two experiments, evoked potentials (EPs) were obtained for three levels of attention, defined by instructions to press a button to, listen to or ignore an infrequent event. In experiment 1, a regular train of standard tone pips was occasionally and randomly interrupted by a tone of different pitch (pitch change) or by the omission of a tone (gap). At the vertex (Cz) a late positive peak (P3) to the infrequent event became larger and later with increased attention, while the earlier negative peak (N1) became later but not larger. In experiment 2, EPs to pitch changes were recorded from Cz, frontal (Fz) and parietal (Pz) locations. All effects obtained in experiment 1 were replicated. The distribution of P3 was different during the different attention conditions.

- 368** Ford, J. M., Roth, W. T., & Kopell, B. S. Auditory evoked potentials to unpredictable shifts in pitch. Psychophysiology, 1976, 13, 32-39.

Auditory evoked potentials (EPs) were recorded from subjects presented with a regular series of tone pips at one of three rates (1/sec, 2/sec, or 4/sec). Occasionally one of the pips was 5%, 25%, or 100% (an octave) different in pitch from the repetitive background pips. These "mismatch" tones occurred at random with a mean interval of 12 sec (range 1-24 sec) for all of the repetition rates. This determined an average sequential probability = 0.083, 0.042, 0.021 that a tone would be a mismatch. On different runs, subjects either responded with a button press each time they heard a mismatch or they read a book. The amplitude of a large negative component (N2 at 154 msec) evoked after mismatch tones was unrelated to degree of mismatch but was larger to all the mismatch tones than to the background pip. Instructions to attend did not affect N2. A subsequent positive peak at 277 msec (P3), recorded during reading, did increase in amplitude with increasing mismatch, as did a P3 at 330 msec recorded during responding. Sequential probability had no main effect on N2 or P3. This lack of an effect on P3 suggests that the well-known influence of stimulus uncertainty on P3 may be determined by the temporal rather than sequential uncertainty of events, or that our range of probabilities was too narrow to obtain the effect.

300 Ford, J. M., Roth, W. T., & Kopell, B. S. Event-related potentials to omitted tones of different durations. Psychophysiology, 1977, 14, 99-100. (Abstract)

Ten subjects received a sequence of tones occurring every 472 msec. They counted the occasional random deletion of a tone. Subjects fixated on a light that flashed on for 50 msec at the onset of each tone and each missing tone. The flash indicated exactly when the tone would have occurred. There were 2 runs for each subject, the order of which was counterbalanced across subjects. In one run the tones were 50 msec long and in the other 400 msec long. Thus, in the short tone run, there was about six times more silence than in the long tone run.

Event-related potentials (ERPs) to background and missing tones were recorded from electrodes at F_z, C_z, and P_z referred to linked earlobes. Trials with eye movements or blinks were rejected by the computer.

The background tones elicited an N1 (113 msec) and P2 (180 msec). N1 was later to the long than to the short tones. At F_z and C_z, P2 was smaller to the long than to the short tones.

The missing tones elicited N2 (160 msec) and P3 (358 msec). N2 was largest centro-frontally, suggesting that it was not the N1 of the visual ERP. P3 was largest at P_z.

N2 to the missing tone was more than twice as large in the long tone sequence as in the short. P3 was not affected by this variable. N2 to the missing tones in the long tone sequence is probably not part of the off-response to the preceding long tone as there is no known prolonged negativity at that latency in off-responses. Instead, N2 might reflect the relative improbability of events, the event being silence in this case.

312 Ford, L. R. Recommended procedure for evaluation of the effects of biological rhythms on a maintenance task. Red River Army Depot, TX.: USAMC Intern Training Center, March 1974. (NTIS No. AD 786 499)

This paper examines past research concerning biological rhythms and human performance and suggests methods for future research concerning biological rhythms and their effects on performance of a maintenance type task. Many studies have been done concerning biological rhythms but relatively little research has been directed toward the effects of biological rhythms on performance of an actual motor task. While no substantial conclusions can be drawn from this paper, it does point out that future research is desirable and suggestions are offered for directing future research.

- 371** Foret, J., & Lantin, G. The sleep of train drivers: An example of the effects of irregular work schedules on sleep. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

Perhaps most important are the possible long-term consequences of disturbances of the sleep-waking alternation such as are experienced by the train drivers. Even without considering actual pathology, it seems legitimate to hypothesize that fighting the circadian rhythms (and we saw how strong they are) has a physiological cost that one should attempt to evaluate. This brings us back naturally to the main theme of this article, i.e., human performance. In the type of job we studied the problem is that the subject's performance must remain the same for ten or twenty years. It is easy to understand why we hesitate to extrapolate laboratory results even when they have been obtained over a long period of time. Although it is clear that immediate relationships between sleep loss and the human operator's efficiency do exist, there is an implicit belief that complete recovery always occurs after such loss. This belief may not be justified in the case where the 'experiment' is repeated almost every day, since it is known that with increasing age there is a corresponding decrease in the ability to adapt to changes in life rhythms.

- 372** Frankenhaeuser, M. Behavioral efficiency as related to adrenaline release (Tech Rep. 268). Stockholm, Sweden: University of Stockholm, Psychological Laboratory, November 1968.

The importance of the adrenomedullary system for maintaining the behavioral efficiency of an individual exposed to environmental influences characterized by either overstimulation or understimulation is illustrated by results obtained in a series of experimental investigations. Consistent relationships between adrenaline release and efficiency of performance during stress are demonstrated. Furthermore, data are presented which show a significant, positive relationship between adrenaline release and intellectual level. The results are supported by data obtained in experiments with adrenaline infusions.

- 373** Frankenhaeuser, M. Behavior and circulating catecholamines. Brain Research, 1971, 31, 241-262.

It may be stated that the importance of circulating adrenaline for a variety of psychological functions has been clearly demonstrated by experimental results, while the possible significance of circulating noradrenaline in relation to behavior remains obscure. The data available today suggest that the concept of adrenaline as an 'emergency hormone', facilitating fight and flight reactions under conditions inducing rage and fear, should be extended to include also the coping behavior of healthy individuals exposed to everyday stress situations. The mechanism by which adrenaline influences the central nervous system is not yet understood, but data from behavioral studies clearly show that adrenaline secretion is related to both cognitive and emotional functions. [A section of the report relates vigilance performance to adrenaline secretion.]

- 374** Frankenhaeuser, M. Sympathetic-adrenomedullary activity, behaviour and the psychosocial environment. In P. H. Venables & M. J. Christie (Eds.), Research in psychophysiology. New York, London, Sydney: Wiley, 1975.

The article covers the following topics:

- 4.1 Introduction
 - 4.1.1 Adrenomedullary secretion
 - 4.1.2 Action of adrenomedullary hormones
 - 4.1.3 Urinary and plasma catecholamines as indicators of sympathetic-adrenomedullary activity
- 4.2 The Influence of Psychosocial Factors on Sympathetic-adrenomedullary Activity
 - 4.2.1 Novelty, habituation, and control
 - 4.2.2 Level of stimulation
 - 4.2.3 Affective tone
- 4.3 Interindividual Differences in Sympathetic-adrenomedullary Activity
 - 4.3.1 Efficiency and adjustment
 - 4.3.2 Sex differences
- 4.4 Discussion
 - 4.4.1 The influence of cognitive factors
 - 4.4.2 Mechanisms of action
- 4.5 Acknowledgment
- 4.6 References

Section 4.3.1 relates reaction time and errors to differences in adrenaline and noradrenaline secretion rates.

- 375** Frankenhaeuser, M. The role of peripheral catecholamines in adaptation to understimulation and overstimulation. In G. Serban (Ed.), The psychopathology of human adaptation. New York: Plenum Press, In press.

The paper reviews data from laboratory and field investigations aimed at identifying those aspects of the psychosocial environment which elicit secretion of catecholamines. It is shown that (a) cognitive factors, e.g., the individual's ability to predict and control events in his environment, regulate his level of catecholamine arousal, (b) catecholamine release is accompanied by increased alertness and efficiency and hence facilitates adjustment to the demands posed by the environment, (c) individual differences in the intensity and duration of catecholamine secretion in response to underload and overload are related to differences in short-term and long-term adjustment, (d) the two sexes differ with regard to their average catecholamine release under stress, adrenaline being a less sensitive indicator of behavioral arousal in females than in males, (e) sawmill workers, holding machine-paced jobs characterized by extreme lack of personal control, monotony, coercion and physical strain, have high levels of catecholamine secretion, and in addition, a high frequency of psychosomatic symptoms and high absenteeism.

- 376** Frankenhaeuser, M., Mellis, I., Rissler, A., Bjorkvall, C., & Patkai, P. Catecholamine excretion as related to cognitive and emotional reaction patterns. Psychosomatic Medicine, 1968, 30, 109-120.

Excretion rates of adrenaline and noradrenaline, performance in an audiovisual conflict test, and subjective reactions to the test as well as habitual response patterns were examined in 25 subjects. Subjects with high excretion rates of both hormones performed better during the entire stress session than did subjects with low excretion rates, the trend being particularly pronounced in respect to noradrenaline excretion. Subjects with high or with low excretion rates of both hormones had different time patterns of emotional involvement; high excretion rates were associated with a decrease and low excretion rates with an increase in the intensity of the reactions as the session progressed.

- 377** Frankenhaeuser, M., Myrsten, A. L., Post, B., & Johansson, G. Behavioural and physiological effects of cigarette smoking in a monotonous situation. Psychopharmacologia, 1971, 22, 1-7.

Sustained performance in a visual reaction time test was examined in 12 moderate smokers. In a control condition without smoking, efficiency decreased over time. In a condition, where 3 cigarettes were smoked at 20-min intervals, the subjects were able to maintain their initial level of performance throughout the session, mean reaction times being significantly shorter in the smoking than in the control condition. Smoking produced a significant increase in adrenaline excretion and heart rate.

- 378** Frankenhaeuser, M., Nordheden, B., Myrsten, A. L., & Post, B. Psychophysiological reactions to understimulation and overstimulation. Acta Psychologica, 1971, 35, 298-308.

Catecholamine output, heart rate, and performance efficiency were examined in 28 Ss during two contrasting stimulus conditions, one of understimulation, and one of overstimulation. During understimulation the subject spent 3 hrs performing a vigilance task, and during overstimulation he was exposed for the same time period to a complex sensorimotor test. Both understimulation and overstimulation produced a significant increase of adrenaline and noradrenaline release as compared with a control condition involving a medium amount of stimulation. Subjects who excreted relatively more adrenaline performed significantly better during understimulation, whereas subjects with relatively lower excretion rates of adrenaline tended to perform better under overstimulation. When performance efficiency was related to heart rate it was shown that high-heart rate subjects performed better during understimulation, while low-heart rate subjects performed better during overstimulation.

- 379** Frankenhaeuser, M., & Rissler, A. Effects of punishment on catecholamine release and efficiency of performance. Psychopharmacologia, 1970, 17, 378-390.

Physiological and psychological reactions were studied in 40 subjects under four different conditions. In Session I the subjects received electric shocks according to a random schedule which they could not influence. In Sessions II and III a choice-reaction task was performed, and half of the subjects were punished for slow performance, the degree of situational control exerted by the subjects being greater in session III. Session IV was spent by all subjects in passive relaxation. Punishment produced a rise in both adrenaline and noradrenaline release. By increasing the subject's control over the situation it was possible to counteract the adrenaline increase, while noradrenaline release appeared unaffected. On the whole, subjects with high as compared with low rates of adrenaline and noradrenaline excretion were more efficient in terms of both speed and accuracy of performance.

- 300) Franzen, O., & Offenlock, K. Evoked response correlates of psychophysical magnitude estimates for tactile stimulation in man. Experimental Brain Research, 1969, 8, 1-18.

Cortical responses evoked by transient sensory stimulation of the index and middle fingers were recorded from the scalp over the contralateral primary somatic projection area in man. Stimulus amplitude and locus were systematically varied. The relationship between stimulus intensity and the magnitude of the evoked response is adequately described by a power function. The exponent of the psychophysical function generated under similar stimulus conditions is of approximately the same size. A mathematical model is presented to describe and predict spatial summation. A complete isomorphism between psychological and neurophysiological events is obtained.

- 301 Frazier, T., Benignus, V., Every, M., & Parker, J., Jr. Effects of 72-hour partial sleep deprivation on human behavioral and physiological response measures. Falls Church, VA.: Bio Technology, Inc., August 1971. (NTIS No. AD-732872)

Ten adult males were subjected to partial sleep deprivation experiments in order to study the effects of progressive sleep deprivation on the basic biological rhythms underlying performance on signal detection tasks and to assess the value of using change in biological rhythms as an objective measure of human response to such types of stress. The data obtained were subjected to a power density spectral analysis with a program based upon the Fast Fourier Transform. The results show that signal detection measures, response latency, and heart rate are all highly sensitive in reflecting progressive loss of performance capability. Power spectral data also show changes as a function of sleep deprivation, indicating that one feature of this type of stress may be an alteration of basic human biorhythms.

- 302 Frazier, T. W., Rummel, J. A., & Lipscomb, H. S. Circadian variability in vigilance performance. Aerospace Medicine, 1968, 39, 383-395.

Least-squares spectral analyses of vigilance performance by three human test subjects over a 14-day confinement period in a highly controlled experimental environment revealed clear evidence of circadian rhythmicity. Four performance tasks associated with vigilance measurement were administered on four equally-spaced occasions during each day of the test. Circadian rhythmicity was identified in every measure employed, but individual circadian periods showed clear nonstationarity as time progressed, with periods ranging considerably above and below 24 hours. This finding raises some questions regarding the common practice of using time-of-day control for eliminating circadian periodicity as a source of error variability and questions regarding whether circadian variation might account for vigilance performance changes previously associated with length of a monitoring vigil. The results also suggested that confinement stress can lead to alterations of circadian rhythmicity, even when the physical environment and activity schedule are held highly constant.

- 303 Frazier, T. W., Weil-Malherbe, H. W., & Lipscomb, H. S. Psychophysiology of conditioned emotional disturbances in humans. Psychophysiology, 1969, 6, 478-503.

A discriminative avoidance conditioning technique was used to study urinary excretion of selected adrenal hormones in response to a stimulus which had acquired conditioned noxious properties through association with availability of punishment. A four day test procedure was employed: (1) to habituate subjects to the test environment; (2) obtain control data; (3) condition subjects; and (4) test reactions to the conditioned noxious stimulus. Urine samples were taken at two-hour intervals preceding and following each of the four trials, and were analyzed for epinephrine, norepinephrine, total 17-hydroxycorticosteroids, and other urinary constituents. These results were correlated with results obtained from monitoring of heart rate, skin resistance, blood pressure, and three measures of panel monitoring performance. Data analyses revealed significant changes from control levels during the test period for each of the principal measures described above and some specification of life systems interrelationships through correlation and factor analyses. Factors were identified which related to behavioral efficiency, psychological effort, fluid transport regulation, cardiovascular-adrenal, and specific epinephrine and norepinephrine factors.

- 304 Frazier, T., West, V., Every, M., & Parker, J. Jr. Use of spectral analysis in the study of human behavioral and physiological response measures. Falls Church, VA.: Bio Technology, Inc., June 1971. (NTIS No. AD-732951)

In assessing changes in behavior, such as those found with sleep loss, the principal problem is one of measurement. The objective of the series of studies described in this report was to develop and validate a measurement and analysis technique for examining human responses occurring through time. In the six studies reported, power spectra were computed for experimental data, along with coherence analyses and tests of significance. Behavioral results were compared with one another and with simultaneously recorded physiological data. The data from these studies indicate there are several rather stable biological rhythms, or oscillations, which occur in performance patterns. Several oscillations were identified in addition to the large (1.1 cycles/day) oscillation which corresponds to circadian rhythm. Oscillations of weaker intensities were found at 4.5, 9.0 (close to the work/rest cycle), and 18 cycles/day. The imposition of mild stress conditions was found, in many instances, to have a significant effect on the character of the basic biorhythms. It is felt that the use of time series data, in which rhythmicities in performance are identified and studied as the organism is exposed to unusual or stressful environments, represents a relatively new and potentially fruitful approach to behavioral research.

- 306** Freeman, G. L. The facilitative and inhibitory effects of muscular tension upon performance. American Journal of Psychology, 1933, 45, 17-52.

To critical students, it is now quite evident that the relationship between mental activity and muscular tension is far from simple. One of the most perplexing problems of contemporary research concerns the universal validity of muscular reinforcements. Data obtained under widely different conditions indicate that increments in tension may (1) increase efficiency of performance, (2) have no effect on it, or (3) be actually inhibitory. Such apparently contradictory results point to the necessity of further work, both with more refined techniques and with more rigid experimental controls.

Our general problem has thus been formulated as follows: When may muscular tension facilitate performance and when is it likely to be inhibitory? This paper describes several new approaches to the question and attempts to clarify the interpretation of data obtained from other sources.

- 308** Freeman, G. L. The relationship between performance level and bodily activity level. Journal of Experimental Psychology, 1940, 26, 602-608.

From the three experiments reported above, and especially for the last one, it is suggested that changes in skin resistance are more related to subjective effort than to performance level per se. The fact that it is often difficult for an individual starting from a relatively high level of reactivity to attain a slow working pace, makes for many reversals in the assumed decrease in reactivity and under lowered performance. Furthermore, measures of work-output alone are insufficient to show the assumed relationship; for while an individual working at high or low excitation levels may turn out the same amount of work as at a more congenial pace, a decrement in the quality of performance can have occurred. Another complicating factor is the possibility of change in work methods at different production rates, which would tend to mask the relationship between effectiveness of performance and reactivity. Later research may conceivably show that the extremes of this relationship are attained only when resting excitation level, from which increments obtain during work, is abnormally high or low. Certainly this is the implication from our second experiment, done on a single subject.

- 307** Friedman, H., & Taub, H. A. The transephalic DC potential and disjunctive reaction time performance. Bulletin of the Psychonomic Society, 1973, 1, 202-204.

Investigated the relationship between the transephalic DC potential (TCDC) and disjunctive reaction time (RT) in 239 clinically normal male Ss. Three experiments were conducted with visual and 2 with auditory presentation of stimuli. In each experiment, comparisons of those Ss shifting in TCDC in a positive direction vs. those shifting negatively and/or less positively were made. In every case, the group of Ss shifting in the relatively more positive direction showed a significant association between TCDC and a change toward slowing of RT performance.

- 388** Froberg, J. E. Circadian rhythms in catecholamine excretion, performance and selfratings. (Report No. 36.) Stockholm: Karolinska Sjukhuset, Laboratory for Clinical Stress Research, April, 1974.

Circadian variations have been found in adrenaline excretion as well as in performance and subjective arousal. No study, however, has yet been reported in which all three aspects of arousal - physiological, subjective and behavior - have been measured simultaneously. We have studied - in a series of experiments designed to test the ability of military personnel to endure a three-day vigil under conditions of continuous activity and a 'stressful' milieu - circadian rhythms in catecholamine excretion, performance and 'subjective arousal'. The present paper is concerned with two experiments, in which a total of twenty-nine subjects were deprived of sleep for seventy-two hours with three hourly measurements of urinary catecholamines, self-ratings, and performance. The purpose of this study was to answer the following questions: (1) Are there psychophysiological circadian rhythms which persist under conditions of sleep deprivation with continuous activity and regularly spaced meals? (2) If so, what are their characteristics in terms of the shape of the curves, phases and amplitudes? (3) What time relationships exist between different functions, i.e. physiologic, subjective and performance measures?

- 389** Froberg, J., Karlsson, C. G., Levi, L., & Lidberg, L. Circadian variations in performance, psychological ratings, catecholamine excretion and urine flow during prolonged sleep deprivation. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

The psycho-physiological correlations reported may be due to at least two main factors: (1) progressive changes due to sleep deprivation etc. per se., and (2) the circadian variations. Making the assumption that the former effects are approximately linear with time, partial correlations were computed. The results of this analysis indicates that when the effect of h. of sleep deprivation is 'partialled out', the correlations between adrenalin excretion on the one hand and performance and fatigue measures on the other, are clearly significant and of the same magnitude or even higher than those reported ($r = .80$ and $.48$ for number of shots, and $-.70$ and $-.68$ for fatigue ratings for Experiments I and II, respectively). Partial correlations between noradrenalin and performance and fatigue, however, were not significant in any case. These results support the assumption that there is a relationship between the rhythms of adrenalin, performance and fatigue, while the correlation between the two latter variables and noradrenalin excretion are due primarily to 'stress-induced', progressive changes.

360 Fruhstorfer, H., & Bergstrom, R. M. Human vigilance and auditory evoked responses. Electroencephalography and Clinical Neurophysiology, 1969, 27, 346-355.

1. In seven normal subjects vigilance fluctuations and related changes in the auditory evoked response were quantitatively analysed during rest lasting 10 min (eyes open) or 80 min (eyes closed) in a soundproof room. Vigilance was visually determined from the EEG on the basis of a sensitive classification. Responses evoked by slowly repeated clicks were summated selectively according to the vigilance level in the 2 sec immediately prior to each stimulus.

2. During a session vigilance decreased noticeably in all subjects whether the eyes were kept open or closed. With closed eyes the vigilance decrease was rapid and in most cases reached real sleep. After this initial fall vigilance increased again and remained, with smaller oscillations, at a certain level of the intermediate stages.

3. The click-evoked response was large and stable in the alert state. With decreasing vigilance a progressive amplitude reduction of three prominent response components (N_{1a} , N_{1b} , P_{2b}) was observed. At stage B₂, these components had approximately 25% of their original size at stage O. The transition to real sleep was characterized by a marked increase of N_2 and a slight growth of P_{2a} . P_1 did not change over the whole vigilance range.

4. No progressive changes in latency or shifts in focus were noticed. There was, however, a decrease in latency and a posterior shift in the focus of N_2 at the transition to real sleep.

5. The progressive loss in amplitude is interpreted as a decline in the activity of certain brain functions which are essential for the maintenance of an efficient subject-environment relation.

361 Fruhstorfer, H., Langanke, P., Meinzer, K., Peter, J. H., & Pfaff, U. Neurophysiological vigilance indicators and operational analysis of a train vigilance monitoring device: A laboratory and field study. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

Vigilance and attentiveness of train drivers is usually tested by vigilance monitoring devices (VMD) which require certain motor responses. The continuous performance of this "secondary task" over years may, however, improve the ability of the driver to respond correctly in states of lowered vigilance during which his overall performance is reduced. This problem has to be studied by comparing the performance of the secondary task with objective neurophysiological vigilance indicators. The present study progresses on three levels. The actual performance of drivers operating the VMD is studied on an electric engine. The performance of trained and untrained subjects operating the VMD is compared to neurophysiological vigilance indicators (EEG, EOG) in a laboratory simulation. Neurophysiological vigilance parameters together with the operation of the VMD were examined in a monotonous car driving situation. The results so far obtained indicate that the engine drivers develop a spontaneous and rhythmic way of operating the VMD which allows a correct operation of the system even at low levels of vigilance.

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- 392** Gaarder, K. Fine eye movements during inattention. Nature, 1966, 209, 83-84.

A feedback control system of fine eye movements might be assumed from this evidence to operate differently during attention and inattention. Most parsimoniously, it could be assumed that during attention there is a closed-loop feedback functioning with stability of the system, while during inattention the loop is opened, resulting in typical instability oscillation as recorded in artificially opened loops by Fender and Nye. Thus, inattention would physiologically involve the opening of feedback loops which are ordinarily closed and operative. Although parsimonious, these assumptions should be tentative.

Another issue concerns the state of organization of visual information transmitted during attention and inattention. Introspection does not readily allow asking if what we see during inattention is different from during attention. The different space-time relationship of the retinal image to the retina during attention and inattention suggests that the organization of information transmitted by the optic nerve might be markedly different in the two states.

- 393** Gaillard, A. W., & Naatanen, R. Modality effects on the contingent negative variation in a simple reaction-time task. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

The modality of the stimuli used had a clear influence on the amplitude of the CNV in the simple RT task. For the vertex and temporal derivations the modality of S_1 had a large effect on the CNV amplitude especially when the amplitude was measured in the early phase (600-760 msec after S_1). No effect of the S_1 modality on the CNV was observed in the occipital data.

Whether the modality effects observed are 'real', i.e. specific to the modality or only due to stimulus intensities used has still to be investigated. A crucial experiment is difficult to design due to the fundamental problem of comparing stimulus intensities across modalities. Up to the present time even the influence of stimulus intensity on the CNV has not been systematically enough investigated.

Future investigations of stimulus modality effects will need to pay particular attention to the nature of the task, the i.s.i., electrode positions and the duration of experimental conditions and tasks.

- 394** Gale, A. The psychophysiology of individual differences: Studies of extraversion and the EEG. in P. Kline (Ed.), New approaches in psychological measurement. London: Wiley, 1973.

Of all the paradigms outlined above, the vigilance paradigm is possibly the best candidate for immediate research, since it may call upon a body of established data. However, the remaining paradigms may be worked upon to yield useful data. All these tasks represent a considerable shift in ecological validity when contrasted with the 'eyes closed' and habituation paradigms. The only justification for further work along the lines of the existing studies would be merely to clarify their equivocal findings. We may end this case study in experimental mismanagement with a glimmer of optimistic, if not fervent, hope.

- 395 Gale, A. EEG studies of extraversion-introversion: Sources of experimental error. Paper presented at the International Conference on Temperament and Personality, Warsaw, Poland, October 1974.

In a series of small-scale studies we have shown that imaging characteristics relate to the EEG; that differences in short term recall both within and between subjects are related to resting and in-task variation in the EEG; that eye-to-eye contact and interpersonal distance have systematic effects upon the EEG; that individual differences in simple reaction time relate to EEG abundance and frequency, and finally, that variation in parameters of stimulus complexity relates both to EEG variation and to subsequent capacity to recognize the stimuli. For much of this data there is already compatible performance data relating to extraversion-introversion. Even where such data is not yet available, the paradigms themselves may lead to new data; for example studies of stimulus complexity and the EEG may enable us to monitor physiological response to stimulus-seeking itself. What we see in our studies is that the same EEG characteristics can be good for some types of performance and bad for others. In vigilance and stimulus recognition; for example, capacity to show differential arousal to varied stimuli is the key to superior performance. In short term recall, lower arousal and reduced variability are associated with good scores in untrained Ss. Our simple reaction time data, which is still being analysed, shows quite strongly that low arousal is associated with fast reaction.

- 396 Gale, A. Some EEG correlates of sustained attention. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

This paper reports two studies of EEG correlates of sustained attention. In the first, signal ratios are varied in a situation in which overall event rate is constant. The EEG is shown to be sensitive to time, signal ratios, and individual differences in performance. The second study measures the effects of coaction in a Bakan-type task in which subjects perform alone or in pairs, are males or females, friends or strangers, working merely together but on different schedules of the same task, or working in direct competition to the same schedule. Both performance and EEG data reflect the influence of the key variables manipulated. Reasons for the current dissatisfaction with the EEG's usefulness as a dependent variable in psychological research are considered, as are means of improving EEG research in general and in vigilance and sustained attention type tasks in particular. It appears from the data presented that different EEG waveforms are differentially sensitive to various task and situational treatments within the waking state. In particular it is shown that tasks which contain either a large short term memory component or a response competition element are likely to confuse the vigilance literature since such characteristics call for lowered arousal if performance is to be successful, whereas traditionally, superior performance in vigilance tasks is associated with heightened arousal. A multi-stage model of experimental arousal is briefly considered and attention is drawn to possible sources of error in measurement if aspects of the model are ignored. It is concluded that the EEG is at least as good a psychophysiological index of arousal as are some of the more popular measures (heart rate, electrodermal activity, slow potentials etc.) and that the EEG is capable of generating some data of relevance to vigilance research.

- 397** Gale, A., Bramley, P., Lucas, B., & Christie, B. Differential effect of visual and auditory complexity on the EEG: Negative hedonic value as a crucial variable? Psychonomic Science, 1972, 17, 21-24.

Four experiments are reported. In Experiment 1, EEG abundance is shown to decrease as complexity of visual stimuli increases. Stimuli are a blank screen or 2, 4, 8, or 16 black dots randomly placed on a white background. This result is in accordance with previous findings and is consonant with arousal theory. However, in Experiment 2, EEG abundance is shown to increase with auditory complexity. Stimuli are 30-sec blocks of 1, 2, 3, or 4 tones randomly alternated. In Experiment 3, Ss rate the sound stimuli for both complexity and hedonic value. Ratings for complexity and hedonic value run counter to each other, Ss rating less complex stimuli as ugly, irritating, and unpleasant. Thus the contradictory results of Experiments 1 and 2 are explicable in terms of the negative hedonic value of simpler, more monotonous stimuli, the arousing effects of which may override any effects induced by complexity per se. In Experiment 4, Ss give hedonic ratings for stimuli used in both Experiments 1 and 2. The findings for Experiment 3 are replicated. An irritating-relaxing scale differentiates between the visual and auditory stimuli.

- 398** Gale, A., Bull, R., & Haslur, M. Cumulative expectancy, subjective report of alertness, and electrodermal activity. Psychophysiology, 1972, 9, 383-392.

Monitored skin conductance during a vigilance task in which 10 undergraduates responded to wanted signals. The wanted signal was a sequence of 3 consecutive odd digits (e.g., 1, 3, 7). Nonwanted signals also contained 3 consecutive digits; of these, 2, 1, or none were odd (e.g., 1, 1, 2; or 1, 4, 6; or 2, 4, 6). Since Ss responded to a series of odd digits the different signal types varied in their power to induce a state of cumulative expectancy. Electrodermal activity was quantified in terms of change in conductance (SCR), either increase (SCR+) or decrease (SCR-) associated with particular sequences of digits. Results indicate: (a) SCR+ for wanted signals progressively increased as the sequence accumulated with maximum SCR+ on the final digit and a large SCR- on the plus sign; (b) odd numbers were associated with SCR+ whereas even numbers and plus signs were associated with SCR-; (c) Ss reported posttest that they were more alerted by odd digits; (d) RT to wanted signals did not correlate with latency of the associated SCR, nor with pre- and postsignal SCRs; (e) intraindividual analysis yielded no evidence for operation of the law of initial value.

- 399** Gale, A., Bull, R., Penfold, V., Coles, M., & Barraclough, R. Extroversion, time of day, vigilance performance, and physiological arousal: Failure to replicate traditional findings. Psychonomic Science, 1972, 29, 1-5.

Examined the effect of extroversion, neuroticism, sex, and time of day on the performance of 190 graduate and undergraduate Ss on a group-administered hr-long auditory vigilance task. Performance was related to none of these variables, but the task yielded a significant decrement in performance during the 1st 12 min, and level of performance was well within the range typically reported for such tasks. Good and poor vigilance performers were then compared on 2 further separate tasks: (a) tonic and phasic electrodermal activity (EDA) during habituation to repeated auditory stimulation ($n = 22$), and (b) tonic occipital EEG during alternated eyes-open and eyes-closed trials ($n = 16$). Of the EDA measures, tonic EDA (basal resistance) discriminated between good and poor vigilance performers. Resistance level of the good group increased during habituation trials and was also higher than that of the poor group following the 9th of 20 trials. The tonic EEG of the good group was higher in amplitude than that of the low group. Results are contrary to predictions made on the basis of arousal interpretations of individual differences in vigilance performance, since both the EDA and EEG measures indicate that good vigilance performers were lower aroused than poor vigilance performers.

- 400 Gale, A., Christie, B., & Penfold, V. Stimulus complexity and the occipital EEG. British Journal of Psychology, 1971, 62, 527-531.

Occipital EEG was monitored during long-term exposure to visual stimulus arrays of five levels of complexity. Integrated EEG output was recorded for nine separate frequency bands. The stimuli were two, four, eight, 16 or 32 randomly located white squares on a black background. Mid-alpha activity (8.5-10.5 Hz) decreased linearly with $\log_2 n$, where n = number of squares in the array ($P < 0.01$). Beta activity (12.5-16.5 Hz) showed a quadratic trend ($P < 0.02$). Theta activity (5.5-7.5 Hz) increased linearly with ascending complexity ($P < 0.05$). There were no significant trends for low alpha (7.5-8.5 Hz) or high alpha (10.5-12.5 Hz). Brightness-control slides showed no parallel effects.

- 401 Gale, A., Coles, M., & Royd, E. Variation in visual input and the occipital EEG: II. Psychonomic Science, 1971, 23, 99-100.

The resting EEG of 29 Ss is examined during exposure to five different conditions of visual stimulation: (1) eyes shut, (2) eyes open in the dark, (3) viewing a blank screen, (4) viewing a simple pattern, and (5) viewing a more complex pattern. Each condition is presented twice according to a random schedule (2 min per trial). For alpha and beta frequencies, EEG amplitude varies inversely with ascending visual complexity. For theta frequencies, this relation holds except for a reversal for Conditions 4 and 5.

- 402 Gale, A., Davies, R., & Smallbone, A. EEG correlates of signal rate, time in task and individual differences in reaction time during a five-stage sustained attention task. Ergonomics, In Press, 1976.

The EEG of 20 subjects was monitored continuously while they performed a sustained attention task in which each subject performed five conditions in different order. All conditions involved regular presentation of digits (stimuli) at the rate of one per two seconds. Subjects were required to respond to particular digits (signals) and signal ratios varied between 10 and 50 percent over the five conditions. There was a brief rest between each condition, and total task time (including periods of rest) was approximately 112 minutes. The Results were: (i) Mean reaction time to wanted signals increased following the first condition (independent of signal ratio) and was also longest for the 50% signal ratio condition (independent of order of presentation). (ii) Errors (false positives and misses) increased as a function of signal ratio but not as a function of order of presentation. Subjects with faster mean reaction time committed more errors. However, overall absolute error rate was low (3.2% under the most extreme condition). (iii) EEG abundance for the lower measured alpha frequencies increased as the task progressed, and mean dominant alpha frequency, decreased. (iv) EEG abundance for the higher measured alpha frequencies increased as a function of signal ratio, i.e. the higher the ratio, the higher the abundance. (v) Subjects with higher EEG abundance and lower mean dominant alpha frequency were faster (mean RT) than subjects with lower abundance and higher mean dominant alpha frequency. (vi) EEG trends were different for fast and slow subjects; fast subjects gave EEG effects for both signal ratio and time in task, whereas slow subjects showed only time effects. The overall findings for time in task and the decreases in the quality of performance with decreased arousal are compatible with previous models of vigilance (e.g. Mackworth, 1969). The unexpected results for signal ratio and individual differences (decreasing EEG arousal with task complexity and greater individual efficiency) are interpreted in terms of (i) loading on short term memory requirements by between-condition interference effects, (ii) inhibition of preparatory motor response to militate against response anticipation, and (iii) evoked orienting responses. Independent evidence suggests that both short term recall and motor inhibition call for lowered arousal if performance is to be successful.

- 403 Gale, A., Dunkin, N., & Coles, M. Variation in visual input and the occipital EEG. Psychonomic Science, 1969, 14, 262-263.

EEG frequency distributions are compared over three viewing conditions eyes-closed, eyes-open with matt black display, and eyes-open with a patterned display of white geometrical shapes on a black background. The distributions for the three conditions (derived from a total recording time of 24 min) may be ranked in accordance with an arousal hypothesis. Integrated output in all measured frequencies is reduced in the more aroused states, and differences between aroused conditions occur within the alpha and subalpha ranges, rather than in the beta range.

- 404 Gale, A., Haslum, M., & Lucas, B. Arousal value of the stimulus and EEG abundance in an auditory vigilance task. British Journal of Psychology, 1972, 63, 515-522.

Assigned a task to 10 18-22 yr. old undergraduates in which the desired signal consisted of 3 consecutive odd digits. Five other signals varied in their approximation to the wanted signal, were ranked on that criterion for their arousal value, and were each followed by a rest period. Results show that (a) alpha abundance diminished as arousal value increased; (b) theta and beta showed weak or no effects; (c) a very-low-frequency filter yielded a strong effect for 1 signal only; (d) during rest periods, alpha signal was greater than during the preceding signal for the 3 most arousing signals and much lower following the others; and (e) Ss rated themselves as more keyed up as arousal values increased, and reported increased alertness during rest periods associated with signals of increasing cue value. It is concluded that variation in alertness as experienced in vigilance tasks is reflected in systematically varied EEG.

- 405 Gale, A., Haslum, M., & Penfold, V. EEG correlates of cumulative expectancy and subjective estimates of alertness in a vigilance-type task. Quarterly Journal of Experimental Psychology, 1971, 23, 245-254.

Monitored occipital EEG during a slow presentation rate vigilance task with 18 male and 7 female undergraduates. EEG samples were taken for each of 400 task events. The EEG is correlated with increases and decreases in "expectancy" built into the task. Posttrial subjective estimates of alertness parallel the EEG changes. RT to "wanted signals" does not correlate with measures of presignal EEG.

- 406 Gale, A., Jones, D. M., & Smallbone, A. Short-term memory and the EEG. Nature, 1974, 248, 439-440.

Studied the relationship between low levels of arousal as measured by the EEG and efficient short-term memory. EEGs of 32 Ss were monitored during the acquisition and immediate recall of 9-digit strings presented in the auditory mode. After an initial 2-min test period, Ss each underwent 24 trials, for which instruction was minimal. The EEG was recorded, stored, and averaged, using low frequency analysis. Thus, the systematic changes which occur in the human central nervous system during acquisition of material to-be-recalled, and the relationship between such changes to subsequent recall, were plotted. It was found that poor performance was consistently associated with increased EEG arousal, even to the extent of enabling prediction of recall error rate before the task proper. Possible interpretations of these results are suggested.

- 407 Gale, A., Jones, D. M., & Smallbone, A. Short term recall of 9-digit strings and EEG. I. Correlates of serial position, practice, within-subject and between-subject differences in recall (auditory presentation). British Journal of Psychology (awaiting decision).

Thirty-two subjects each underwent 24 short-term recall trials. Each trial consisted of a random, 9-digit string, presented in the auditory mode. The EEG was monitored before the task, during acquisition and recall, and between trials. An EEG sample was available for each digit. There were twelve key findings: (i) Errors in recall increased monotonically as a function of serial position ($P < 0.001$) with an improvement in performance for the final serial position ($P < 0.05$). (ii) At the same time, EEG abundance during digit presentation diminished as a function of serial position ($P < 0.01$) such that high error in subsequent recall was associated with decreasing abundance (increasing arousal) during presentation. Several analyses related recall performance to individual differences in the EEG. (iii) Pre-task abundance (7.5 - 9.5 Hz) was inversely related to total error ($P < 0.025$). (iv) Pre-task alpha dominant frequency (7.5 - 13.5 Hz) was directly related to total error ($P < 0.05$). (v) Abundance during acquisition was inversely related to total error ($P < 0.01$). (vi) Degree of diminution in abundance during acquisition (increased activation) was positively correlated with errors in early serial positions ($P < 0.01$). (vii) The patterning of EEG variability at acquisition differed for subjects giving good and poor performance. Good subjects showed initial EEG diminution followed by stabilisation; poor subjects continued to diminish in abundance throughout the series ($P < 0.05$). (viii) Poor subjects were more aroused at recall ($P < 0.05$). (ix) A within-subjects analysis of good and poor recall trials revealed differences similar to those for differences between good and poor subjects (as (vii) above). (x) This finding was corroborated by an analysis of extremes of performance (very good and very poor trials) ($P < 0.01$). (xi) For all subjects EEG abundance between trials was greater than at acquisition or recall ($P < 0.01$). (xii) When the 24 trials were divided into successive blocks of 8 trials, the first block was associated both with high recall errors in the early serial positions ($P < 0.01$) and decreased abundance when compared with the final 16 trials ($P < 0.05$).

All the findings are internally consistent and indicate that good performance was associated with higher levels of EEG abundance and therefore lower levels of arousal. The EEG discriminates between: serial positions during presentation, subjects before task, subjects during digit presentation, subjects during recall, good and poor trials within subjects, trials and inter trial rests, and trials over time. The results are interpreted in terms of an interaction between individual factors of arousal and the effects of knowledge of results upon arousal. They are shown to be consistent with other autonomic nervous system studies of short term recall.

- 408 Gale, A., Spratt, G., Christie, B., & Smallbone, A. Stimulus complexity, EEG abundance gradients, and detection efficiency in a visual recognition task. British Journal of Psychology, 1975, 66, 289-298.

Occipital EEG was monitored while subjects inspected 27 projected patterns. The number (N) and variety (V) of elements in the patterns were varied systematically. There were three levels of N (6, 12, or 24 elements) and three levels of V (circles, squares or hexagons occupying all, one half or one third of the element locations for all level of N). Subjects were instructed that they would be required in a post-test to recognize the patterns, among patterns which had not appeared; they were also informed that the patterns had been constructed according to a set of simple rules, but the nature of these rules was not made fully explicit. The EEG was quantified by means of low-frequency analysis, yielding measures of abundance (theta, alpha and beta) and mean dominant frequency. For the recognition task, nine stimulus items were embedded among 45 items. Recognition efficiency was measured by means of the signal detection theory discrimination index (d'). The results were as follows: (i) Both N and V were inversely related to alpha abundance ($P < 0.01$); (ii) the strongest relationship between stimulus parameters and the EEG held for N and EEG beta activity (13.5-19.5 Hz; $P < 0.001$), where again the EEG and N were inversely related; (iii) there was a significant ($P < 0.05$) direct relationship between N and theta activity; (iv) contrary to prediction, mean dominant alpha frequency decreased as N increased; (v) d' correlated significantly with a number of effects for N, i.e. subjects who exhibited greatest EEG discriminability of items during exposure of the patterns, subsequently obtained the higher detection scores in the recognition task. The work described, therefore, demonstrates that not only do stimulus parameters have systematic effects upon brain activity as measured by the EEG, but that such effects have functional value and reflect aspects of efficiency. The results are fully compatible with arousal theory constructs relating physiological reactivity and performance.

- 409 Galin, D., & Ornstein, R. Lateral specialization of cognitive mode: An EEG study. Psychophysiology, 1972, 9, 412-418.

We have studied EEG asymmetry in normal subjects during verbal and spatial tasks. Recordings were made from the left and right temporal and parietal areas, and the ratios of average power (1-35 Hz) in homologous leads T_4/T_3 and P_4/P_3 were computed. This ratio (right over left) was greater in the verbal tasks than in the spatial tasks. With this measure we have been able to distinguish between these two cognitive modes as they occur in normal subjects, using simple scalp recording.

- 410 Galin, D., Ornstein, R., Kocel, K., & Merrin, E. Hemispheric localization of cognitive mode by EEG. Psychophysiology, 1971, 8, 248-249. (Abstract)

During verbal tasks the integrated power in the left hemisphere was less than in the right, and during spatial tasks the integrated power in the right hemisphere was less than in the left. The results were not affected by whether the eyes were opened or closed, or by eye movement, or by whether the task involved motor output.

Dividing cognition into these two major modes (verbal-analytical and spatial-synthetic) was suggested by observations on brain-injured, neurosurgical, and "split-brain" patients. We have been able to distinguish between these two cognitive modes as they occur in normal Ss, by using simple scalp recording.

- 411 Gambashidze, G. M. [The significance of the diurnal rhythm of physiological functions in evaluating the efficiency of workers in industries operating a three-shift system.] (In Russian) Gigiena Truda i Professionalnye Zabolovaniia, 1961, 6, 13-18.

Investigations in connection with factories operating a three-shift system were carried out in the course of different shifts and at home, during periods of rest. Evidence showed that the efficiency of the workers is determined both by the effect of the physiological diurnal rhythm and by the nature of the tasks performed. It was also found that the diurnal rhythm of physiological functions remains unchanged under high ambient temperatures. Comparative investigations carried out at work-places and at home showed that increased efficiency of workers engaged in three-shift operations can be obtained only by ensuring that they have adequate rest.

- 412 Gancev, G. N., Ganceva, P. N., & Kojceva, V. G. Further on the variability of physiological functions. Works of the Scientific Research Institute of Labour Protection and Occupational Diseases, 1969, 17, 9-12.

Investigation on the variability of pulse frequency during the performance of a task involving a choice and accompanied by neurosensorial or mental tension. In the course of studies involving a given group of persons making a choice or counting over a period of 5-6 days, the authors found that the variability of pulse rate increased whilst the task was being carried out and as the precision required increased. They also found that the information processing rate underwent a similar change as the subject became familiar with a specific task.

- 413 Gang, M. J., & Teft, L. Individual differences in heart rate responses to affective sound. Psychophysiology, 1975, 12, 423-426.

Lacey, Kagan, Lacey and Moss (1963) distinguished between the effects of feedback from the cardiovascular system and from other autonomic systems and suggested that heart rate (HR) acceleration should be associated with stimulus "rejection" and HR deceleration with "attention" or stimulus "acceptance." The present study quantified certain attributes of the sound of the high speed dental engine and tested the effects of this sound on HR and measures of hostility, depression, and anxiety. The study tested the findings of Lacey et al. (1963) and Obrist (1963). Thirty-eight females enrolled at the University of Bridgeport were assigned to one of four groups predetermined by a questionnaire investigating their past experience and familiarity with the dental engine. Heart rate and measures of hostility, depression, and anxiety varied directly with the subjects' familiarity and subjective experience with the acoustic stimuli. Heart rate was found to be more accelerated in subjects who had less experience with and who rated the acoustic stimulus as more unpleasant. Similarly such subjects demonstrated higher scores on anxiety, depression, and hostility scales.

- 414 Gantchev, G., Danev, S., & Koitcheva, V. La frequence cardiaque au cours d'un travail de differente responsabilite et sa correlation avec la quantite de l'information recue et elaboree. [Correlation of heart rate with responsibility and with the amount of processed information.] Activitas Nervosa Superior, 1967, 9, 25-29.

A positive correlation was found between heart rate and (1) the degree of responsibility (banknotes of different amounts were counted), and (2) the amount of information per operation (the number of discriminated signs or the probability of individual signs was varied).

- 415 Gantchev, G., Danev, S., & Koitcheva, V. La correlation entre la frequence cardiaque et la quantite de l'information. [The correlation between heart rate and the quantity of information.] Actes du Troisieme Congres de la Societe d'Ergonomie de Langue Francaise, Bruxelles: Presses Universitaires de Bruxelles, 1968, 352-355.

The results indicate that heart rate increases with the quantity of information. This correlation was established for a quantity of information between 1 and 4 bits, produced by increasing the number of signals, and between 1.18 and 2.45 bits by changing their probability.

- 416 Garcia-Austt, E. Influence of the states of awareness upon sensory evoked potentials. Electroencephalography and Clinical Neurophysiology, 1963, Supplement 24, 76-89.

In every case, the slackening of attention resulted in a decrease of the amplitude of the evoked responses or in their disappearance when the test stimulus was not very intense. The photic response evoked by a single flash in man and in the rat was repetitive during focussing of attention and was simplified during distraction from the stimulus. During habituation, the decrease of the response followed a function that may be expressed as the addition of a short-period (2-4 min) oscillating function plus a monotonic decreasing function of great amplitude.

Attention toward some other sensory pattern, or intense mental activity provoked a decrease of amplitude, or a disappearance of the evoked potentials. The enhancement of attention by association with some other stimulus, by time conditioning, or by "concentration" induced the opposite effect. Similar changes were also observed in the action potential of the auditory nerve in the unanesthetized and unrestrained guinea pig.

- 417 Garcia-Austt, E., Bogacz, J., & Vanzulli, A. Effects of attention and inattention upon visual evoked response. Electroencephalography & Clinical Neurophysiology, 1964, 17, 136-143.

In 98 experiments carried out in 87 normal Ss, changes of the visual evoked response (VER) provoked by modifications of attention were studied. The VER was detected on the scalp of the occipital region by a photoelectric analog computation method. Interference by other stimuli of different or identical sensory modality provoked in the nonhabituated S a reduction in VER amplitude. Performance of a mental calculation task had the same effect. The forced focussing of attention provoked an increase in the amplitude of VER. The influence of habituation upon the changes was very clear. After habituation forced focussing of attention, interference by other stimuli as well as changes in the characteristics of the habituated stimuli provoked an increase in the amplitude of VER. A correlation was established between VER changes, and subjective experience.

- 418 Garcia-Austt, E., & Buno, W., Jr. Relationships between visual evoked responses and some psychological processes. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

1) The Occipital Visual Evoked Response (OVER) is concomitant with some processing of specific visual information, the designation of 'visual response' being therefore pertinent. In the occipital regions this wave is not replicated by auditory stimuli. Its waveform varies on changing the processing of visual information. The spatial characteristics of the stimuli influence the waveform of the response. However, we showed that to maintain the differences determined by two different stimuli it is necessary that the interest and attention of the subject is maintained. When the individual is comparing the relative luminance of two successive stimuli, a double-peak positive process develops with almost the same latency as that of the evoked response. This process changes the waveform of the response in a characteristic pattern.

2) The positive vertex response (PVR) is always present with any type of programme, no matter how simple, and is independent of the stimulus modality. This wave appears with a relatively constant latency once the programme or task has been completed. It augments considerably with uncertainty and, in general, with the increased complexity of the programme. Under certain circumstances the PVR can be very similar to the OVER but its variations with the task changes are very different. It is the wave of the accomplished task, and might be the expression of the reset of the subjective programme.

3) Finally, the contingent negative variation has been recorded in the vertex and in the frontal region but also occasionally in the occipital region. In these regions it may have a different temporal course. This wave is observed at the beginning of the performance with whatever task, even the simplest. The existence of an 'imperative' stimulus is not indispensable. We are not sure whether this wave could be always correlated with expectancy. In some instances the negative variation subsides before the beginning of the next task, when expectancy should be maximal.

- 419 Garcia-Austt, E., Buno, W., Jr., & Handler, P. Changes of occipital evoked response during luminance discrimination in man. In E. Donchin & D. B. Lindsley (Eds.), Average evoked potentials: Methods, results and evaluations. Washington, DC: US Government Printing Office, 1969.

The findings described, together with the fact that we are concerned with a long-latency response, suggest that the occipital VER is not related directly with the crude cortical visual flow. It has been postulated that this response is unspecific and may be obtained with similar features through auditory stimulation (Ciganek, 1967). Under specific conditions, an auditory evoked response may be recorded over the occipital region using low-intensity clicks (Garcia-Austt, 1967). Despite their characteristics and conditions of appearance, they are very different from the visual evoked response. The occipital VER recorded with the foregoing characteristics is therefore regarded as related to, or concomitant with, the specific processing of the visual information and differing considerably from the responses recorded at the vertex, which are unspecific and related to a more advanced stage of information processing.

- 420 Gardiner, M. F. Changes in evoked electrical activity at the scalp of man associated with change in a stimulus-analysis task: A study employing step-wise discriminant analysis (Doctoral dissertation, University of California, Los Angeles, 1969). Dissertation Abstracts International, 1970, 30, 3845B - 3846B. (University Microfilms No. 70 - 2204)

Analysis produced evidence that in all four data analysis sets, change in task situation was associated with a change in the average of EEG activity time-locked to presentation of physically similar stimuli, and also a change in the relationship between stimulus loudness and activity time-locked to stimulus presentation. Evidence was also found that change in task situation was associated with change in relationship between stimulus frequency and activity time-locked to stimulus presentation, in the two sets obtained under condition "A." The results, though based on a relatively small amount of data, showed some encouraging consistency for all the data that was analyzed. The most consistent of such apparent changes in activity, associated with change in task conditions, were observed at lags between 200 and 600 ms after stimulus. Control studies suggested that these changes could not be accounted for by potentials associated with the motor acts used in reporting discrimination decisions, and were not generated by eye blinks or eye movements. They may perhaps indicate differences in physiological processes by which the stimuli are analyzed, and a decision reached, in these different task situations.

- 421 Gardiner, M. F., & Walter, D. O. Differences between human evoked potentials elicited by the same acoustical stimuli during loudness discrimination tasks and pitch discrimination tasks. In E. Donchin & D. B. Lindsley (Eds.), Average evoked potentials: Methods, results and evaluations. Washington, DC: US Government Printing Office, 1969.

In this paper I have made the underlying assumption that, for the time being, we should proceed in human evoked potential research as if horizons are limitless. However, even if this be the case, it cannot be realized without systematic and precise attention to all three domains of variables that enter into the evoked potential experiment — namely the stimulus, the physiology, and the behavior. In this paper, I have limited myself to the problems of specification and definition of one of these three domains — the psychological or behavioral domain. I have outlined some problems in the psychological domain that are particularly relevant to evoked potential experiments that have been done, or problems that are potentially serious in areas which some of us have begun to research.

In the first section, I have emphasized the importance for evoked potential research to obtain data in all three domains in the same set of trials. I have given an example of how this approach assisted in the interpretation of our uncertainty experiments. I have also discussed an example of the problems that arise when one attempts to make quantitative comparisons between psychological and physiological data.

In the second section, I have pointed out some of the problems that arise from the need to repeat stimuli required by the averaging method. This requirement has ramifications which (1) affect the ultimate interpretation of evoked potential data, (2) necessitate randomization of experimental conditions in order to avoid contamination because of habituation, fatigue, boredom, attentional drift, or the formation of inadvertent expectations by the subject, and (3) impose serious limitations on experiments concerned with the meaning of stimuli. It is also suggested that the spatial averaging that is a by-product of recording from scalp makes it highly desirable that the behavioral design of experiments be as simple as possible.

- 422 Gastaut, H., & Bert, J. Electroencephalographic detection of sleep induced by repetitive sensory stimuli. In G. E. W. Wolstenhorne & M. O'Connor (Eds.), The nature of sleep. Boston: Little, Brown, 1961.

Modern life creates many situations in which the problem of vigilance arises. At the same time, in a legitimate concern for improved conditions of work, comfort is often one of the objectives. When an individual guarding a post of safety is situated, as he often is, in a silent place and in a comfortable armchair, one must obviously avoid adding the hypnotic effect of rhythmical sensory stimuli. Thus a loud electric clock, an air conditioner or the regular flashing of lights on a control panel may provide stimuli just as effective as those applied experimentally in this work.

In man's effort to adapt himself to his living conditions, the EEG can play a part which has not yet been recognized. It is not a question here of selecting the best pilots or the best controller for an atomic station. It is a matter of looking for the optimum conditions in which the nervous system may function in situations which are clear-cut and in relation to well-established goals. In this context the possible identification by the EEG of individuals with a marked "internal inhibition" and a tendency to fall asleep through the mechanism of repetitive "inhibition", may render a valuable service.

423 Gastaut, H., Gastaut, Y., Roger, A., Corriol, J., & Naquet, R. Etude electrographique du cycle d'excitabilité cortical, [Electrographic study of the cortical excitability cycle.] Electroencephalography and Clinical Neurophysiology, 1951, 3, 401-428.

The "Cycle of Excitability" consists in the whole of the modifications of excitability of a neuronal population following a preliminary excitation. The authors have studied the excitability cycle in men and in animals by means of photic conditioning and test stimuli. They describe the form and value of the characteristic points of the curve which represents this cycle and they discuss the theoretical significance of this curve according to the parameters of time and amplitude, thus deriving certain criteria of excitability. By increasing progressively the interval between the conditioning and test stimuli, one finds first an absolute refractory period (20 msec) of the cortex, then a relative refractory period (40 msec) followed by alternative periods of increased and decreased excitability (120 and 220 msec). The time taken by the two refractory periods represents the time of recuperation of transitory normal excitability. The time taken by all the periods of the whole cycle represents the time of recuperation of definitely normal excitability.

The refractory periods (recuperation time) could serve as a measure of a "time constant" of a neuronal system, i.e. it characterizes the ability of a neuronal system to respond "more or less quickly" to repetitive stimulation. The average amplitude of the "conditioning curve" depends on the ability of a given system to respond "more or less strongly" to a single stimulus (degree of neuronal synchronization). The average amplitude of the "test curve" expresses a post-excitatory state of subnormality (or supernormality).

424 Gastaut, H., Regis, H., Lyagoubi, S., Mano, T., & Simon, L. Comparison of the potentials recorded from the occipital, temporal and central regions of the human scalp, evoked by visual, auditory and somato-sensory stimuli. Electroencephalography and Clinical Neurophysiology, 1967, Supplement 26, 19-28.

The authors have studied the potentials evoked by visual, somato-sensory and auditory stimuli recorded simultaneously from surface electrodes at theinion, in the occipital, temporal and parietal regions and at the vertex, using an ear electrode as reference. The integrator used was the Alvar Mnemograph. The results showed that for visual and somato-sensory responses the first deflections I, II and III occurred predominantly or exclusively in the corresponding specific regions. Conversely, the late parts of these responses diffused over the whole scalp. For the visual evoked potential it could be seen that component Vc spread the most, corresponding with wave P1 at the vertex.

Auditory stimuli did not seem to give a specific response but rather a non-specific response predominant at the vertex. One of the results of this study was to show the similarity existing between the vertex responses obtained with different modes of stimulation, which warrants a further warning from the authors against the use of the vertex electrode as reference.

- 425 Gatchel, R. J., & Lang, P. J. Accuracy of psycho physical judgments and physiological response amplitude. Journal of Experimental Psychology, 1973, 98, 175-183.

Investigated the effects of an auditory judgment task on physiological responding in 2 experiments with 10 male undergraduates each. Ss were instructed to discriminate pure tones varying along a particular stimulus dimension. The stimulus set in Exp. I consisted of 5 tone intensities. In Exp. II, 5 tones differing in frequency were presented. In both studies, the difference between the initial acceleratory peak and the subsequent deceleration of the cardiac wave form reliably differentiated between stimuli on the basis of judgmental accuracy. Cortical slow-wave activity recorded in Exp. II covaried with accuracy of discrimination.

- 426 Gautier, H., Hanotel, H., & Hugelin, A Niveau de vigilance et type des mouvements respiratoires chez l'Homme éveillé. [Level of vigilance and type of respiratory movements in waking man.] Journal de Physiologie, 1965, 57, 246.

In experiments on 17 adult Ss, vigilance was estimated by EEG, GSR, and heart-rate measurements. Respiratory activity was assessed by pneumotachography and rapid analysis of expired CO₂. Vigilance levels were manipulated by a series of tasks. The results are entirely consistent with previous animal research. Changes in vigilance characteristically go with shortening of expiration, and then an increase in the slope of inspiration. Tidal volume is unchanged during brief changes of vigilance, and diminishes during sustained attention. The effects of apnea are shown to be notably different.

- 427 Geldreich, E. W. Some physiological concomitants of mental work. Psychological Monographs, 1953, 67 (8, Whole No. 358)

The average rates of respiration and heart beat are significantly greater during the mental work of color naming than during either the continuous work of random pressing of a psychrometer keyboard or gazing at serially presented colors.

Relative blood pressure significantly increases during color-naming work but significantly decreases during continuous keyboard-operating work and during continuous passive sensing of serially presented colors.

The level of palmar conductance maintained during the different forms of work is related to the task difficulty, the degree of alertness, the amount of bodily tension, and the amount of energy mobilized to respond to the task situation.

A true control base line for physiological activities of minimal mental alertness is difficult to maintain for young adults for a period longer than ten minutes without the intrusion of sleep. All records of physiological responses of an hour of mental repose show a continuous slight decline for the first half hour before the true base line of physiological activity appears.

The changing rates of respiration and heart beat, and the changing level of palmar skin conductance during continuous color-naming work are positively correlated with the changing rate of color naming and negatively correlated with the changing frequency of blocking.

Changing physiological activities reflect changes in energy mobilization. As color-naming work output decreases, the amount of energy mobilized decreases. Mental work output is a function of the momentary mobilization of energy, the momentary and previous conditions of the circulatory and neuromuscular systems, and the momentary receptivity of the subject to further stimulation.

The changing association between galvanic skin responses and color-naming blocks indicates the existence of at least two types of blocks: galvanic and non-galvanic.

Galvanic blocks are large blocks or "block groups" which result from momentarily shifted attention and reduced alertness. The subject is quite aware of this block and is forced by the task pressure to reorient attention to the immediate stimulus.

The nongalvanic block is more automatic and spontaneous in its production. The subject responds as though the blocked response were a normal variation in color-naming reaction time. This type of block is more a function of response competition than is the galvanic block. As alertness diminishes, loss of control is evidenced by the increasing frequency of nongalvanic blocks.

- 428 General discussion: Future research needs. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

An open forum on future research needs was held at the conclusion of the symposium. The following topics were discussed:

1. Outstanding problems in theory and application.
2. Tests for use in experimental studies.
3. Problems of methodology and analytical techniques (Particularly time-series analyses).
4. Selection of appropriate subjects for experiments.
5. Organization of research effort, and its financial and logistic support.

- 429 Gengerelli, J. A., & Parker, C. E. Spectrographic analyses of EEGs under conditions of alertness and relaxation. Journal of Psychology, 1965, 63, 67-72.

Analyses of human EEGs were made with a spectrum analyzer under conditions of perceptual alertness and of relaxation. The range of frequency components studied was from zero to 30 cps. Comparison of the spectrograms obtained under the two conditions showed a marked diminution in the amplitude of frequency components below 15 cps, but no increases anywhere in the spectrum. In some subjects there was diminution in amplitude in the high frequency components also, but this change was quite small.

- 430 Genkin, A. A. Srednii uroven' asimmetrii dlitel' nosti faz al'fa ritma i skorost' pereabotki informatsii v zritel' no-motornoj sisteme. [Average level of asymmetry of length of phase duration of alpha-rhythm and the rate of information processing in the visual-motor system.] Biofizika, 1965, 10, 868-873.

The data suggest that the "electric processes registered from the surface of the head, exhibit not only a reflection of certain summated phenomena, corresponding merely to the course of specific physiological processes, but are connected with mechanisms of information processing in the cerebral cortex." In any case, statistical analysis of the length of the ascending and descending phases of the EEG discloses new possibilities for correlating neurophysiological and psychological phenomena.

- 431 Genkin, A. A. Sposob razlicheniya signalov EEG pri raznykh vidakh umstvennoi aktivnosti. [Method for discrimination of EEG signals in various forms of mental activity.] Byulleten' Eksperimental' noi Biologii i Meditsiny, 1969, 67, 120-123.

Twenty-two 17-35 yr. old Ss were employed in a study of the informational capacity of a number of statistical indices characterizing the duration of the phases of single EEG waves and their connection with amplitude, as a result of which it proved possible to isolate such indices of the EEG as would permit one to distinguish the EEG reactions during arithmetic calculation and during mental picturization for groups of people, regardless of the spontaneous activity of the EEG and its changes induced by mental activity. The discriminatory algorithm utilized is based on the ratio of likelihood to 2-dimensional probability-density. The data of the study are viewed as proof for the coding, in the EEG, of the neurophysiological processes which are involved in the organization of mental activity.

- 432 Genkin, A. A. Razbienie na klassy psikhofiziologicheskikh svoistv, osnovannykh na vzaimosvyazi povedencheskikh, elektrokorkovykh i elektrokoznykh indikatorov. [Classification of psychophysiological characteristics, based on interrelationships of behavioral, electrocortical and electrocutaneous indices.] Doklady Akademii Nauk SSSR, 1970, 192, 1363-1366.

Nine physiological and psychological measures were taken on 18 adult Ss and correlated. The only significant correlations were those between the rate of information transmission in the visual-motor system and the average level of asymmetry of the duration of phases of parieto-occipital EEG during a 60-sec interval (.65) and between average GSR and the average EEG cycle during a 60-sec interval (.68). The nonsignificant correlations were due to groups of Ss whose data differed in opposite directions. Thus, the interaction of differences in RT to auditory signals of different intensities, EEG asymmetry, and shift in GSR under instructions was found to be due to the existence of Ss with "weak" and "strong" excitatory processes. Ss showing positive correlation between number of errors in a cancellation task and RT also showed a slower EEG, a higher level of EEG asymmetry, and a higher level of GSR in comparison with their complementary counterparts. Results are discussed in terms of the temperamental types of Teplov and Nebylitsin.

- 433 Gerathewohl, S. J. Definition and measurement of perceptual and mental workload in aircrews and operators of air force weapon systems: A status report. In B. O. Hartman (Ed.), Higher mental functioning in operational environments. AGARD Conference Proceedings, No. 181, 1976. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365, Attn: Report Distribution and Storage Unit)

The definition and measurement of perceptual and mental workload in pilots and aircrews becomes increasingly important, because of the introduction of new and sophisticated equipment and procedures into aerial warfare. It is recognized that every mission places certain perceptual and mental demands on the pilot and the crew, which depend on a variety of variables and conditions. Moreover, every mission involves certain tasks, which are either flight oriented or combat oriented. This classification lends itself to a definition of activities as primary or secondary tasks, which has been successfully used in experiments for quantitative determinations of workload.

The determination of pilot and aircrew workload using psychological, physiological, and operational criteria has yielded valuable results. Methods used in civil aviation can be applied with appropriate modifications to military problems. However, workload measurements associated with highly complex and demanding conditions are still difficult. Data are not available from actual combat missions. The results obtained by simulation are promising and may be improved by the standardization of methods and the application of statistical approaches and mathematical models.

- 434 Gerathewohl, S. J., Chiles, W. D., & Thackray, R. I. Assessment of perceptual and mental performance in civil aviation personnel. In B. O. Hartman (Ed.), Higher mental functioning in operational environments. AGARD Conference Proceedings, No. 181, 1976. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365, Attn: Report Distribution and Storage Unit)

Series of experiments were conducted at the Civil Aeromedical Institute of the FAA in Oklahoma City, Oklahoma, in order to study functions of relevance to aircrew, pilot, and ATC performance. They concerned the assessment of mental functions and complex performance on single operators and five-man crews while monitoring static and dynamic processes, of perceptual-motor tracking ability, as well as group problem solving. Operator proficiency was measured at various levels of demand induced by the simultaneous performance of different combinations of tasks, requiring the exercise of psychological and mental processes. It was found that multiple task performance varied significantly as a function of information input and group interaction. Substantial correlations were obtained between perceptual-motor type problem solving and mental ability tests. Moreover, the results obtained from two tracking tasks suggest that a central process exerts a regulatory influence on a variety of physiological variables during increased attention demand and, furthermore, a correlation exists between the ability to sustain attention and personality characteristics of the operator.

- 435 Germana, J. Response characteristics and the orienting reflex. Journal of Experimental Psychology, 1968, 78, 610-616.

Habituation of the orienting reflex (OR) is typically treated as a kind of stimulus learning. The results of 3 experiments employing the GSR indicate, however, that (a) stimuli which have behavioral associates produce greater ORs than those which do not, (b) "new" behavioral associations produce greater ORs than "old" associations, i.e., selective habituation occurs to response characteristics and, (c) level of ORs across habituation trials is a direct function of the amount of response information to be encoded. It appears, therefore that the "neuronal model" of a stimulus includes the characteristics of associated responses.

- 436 Germana, J. Differential effects of interstimulus interval on habituation and recall scores. Psychonomic Science, 1969, 17, 73-74.

Habituation of the orienting reflex (OR) may be viewed as a simple or model form of learning. Previous research (Germana, 1968) has demonstrated that habituation of the OR may take the form of conventional stimulus-response learning and suggested the present comparison between habituation and a behavioral recall measure. Habituation to a 10-digit number was an inverse function of interstimulus interval (ISI), whereas recall of the same stimulus, tested after habituation, did not significantly vary across the range of ISIs employed. It was suggested that the effects of ISI on habituation were primarily determined by increased difficulty of encoding rate of stimulus presentation at increasingly longer ISIs and that behavioral recall does not reflect this temporal dimension of stimulus learning.

- 437 Germana, J. Effects of behavioral responding on skin conductance level. Psychological Reports, 1969, 24, 599-605.

The effects of behavioral response requirements on skin conductance level (SCL) were studied. Initial Ss were placed in either a "non-respond" (NR) or a "respond" (R) condition. No clear effects were observed other than large differences in individual response to both conditions. Subsequent use of a within-Ss replication design showed, however, that behavioral requirements have a tonic effect on SCL and that anticipatory changes in SCL may occur prior to the R condition. The results support the hypothesis that autonomic and behavioral events are essentially integrated and, in addition, suggest the efficacy of the within-Ss replication design in treating individual differences.

- 438 Germana, J., & Chernault, G. Patterns of galvanic skin responses to signal and non-signal stimuli. Psychophysiology, 1968, 5, 284-292.

Reports 2 studies investigating the specific features of GSRs to signal and nonsignal stimuli. The results of Exp. I, with 25 undergraduates, indicate that stimuli which have instructed behavioral associates (signal significance) produce GSRs which are both multiphasic and relatively persistent in nature. Multiple GSRs are produced by the initial presentations of a signal stimulus; the persistence of the overall response has at least a short-term effect on baseline. Exp. II, with 14 undergraduates, studied the possible independence of these 2 characteristics through the manipulation of response certainty. The results suggest that multiplicity and persistence may be separable features of the response to signal stimuli in which the latter may be a correlate of response novelty.

- 439 Giannitrapani, D. Electroencephalographic differences between resting and mental multiplication. Perceptual and Motor Skills, 1966, 22, 399-405.

Average frequency of 30 sec of EEG tracing for resting and mental multiplication (thinking) states was determined for 20 Ss by counting each visually detectable change in pen deflection regardless of amplitude. Results showed: (1) thinking gave higher average activity scores than resting; (2) the difference in average activity between thinking and resting was greatest in the 2 frontal and left temporal areas and was significantly different from other area differences; (3) in the resting state there was a difference between left and right frontal and temporal areas (which increased while thinking) in contrast with a left-right symmetry of the other areas tested. These findings are interpreted as representing characteristic average activity for the areas and conditions tested and are offered as evidence for the differential utilization of brain areas in the given tasks.

- 440 Giannitrapani, D. Frequency analysis of the EEG under different behavioral states. Electroencephalography and Clinical Neurophysiology, 1969, 27, 694. (Abstract)

Arithmetic showed increase in fast activity (21 to 33 c/sec) bilaterally, anteriorly more in prefrontal areas; for Noise, an increase in fast activity (23 to 31 c/sec) in prefrontal and temporal areas bilaterally. Music simulated Noise but more weakly, with decrease at 19 c/sec and increase at 33 c/sec in the left occipital area. Voice simulated Noise, but in slightly higher frequency bands (27-33 c/sec). Voice also showed a decrease in alpha activity in the R. post temporal and R. occipital areas, and decrease in 19 and 33 c/sec in the L. occipital area.

The two visual conditions showed overall changes in the prefrontal, temporal, post temporal, parietal and occipital areas, as well as selected changes in other areas. The relevance of these findings in light of current neuroanatomical knowledge is discussed.

- 441 Gibson, D., Baker, G., & Rathie, E. Effects of size-brightness and complexity of non-meaningful stimulus material on EEG desynchronization. Psychonomic Science, 1967, 8, 503-504.

Latency and duration of EEG desynchronization were measured while Ss were exposed to nine slides varying in complexity and size-brightness. There was a positive relationship between duration of EEG desynchronization and the simple stimulus impact variable but no effect due to nonmeaningful complexity levels. There was no relation between duration of latency period and either stimulus complexity or size-brightness. The results were evaluated in the context of the "collative variables" hypothesis and the alerting scanning, and integrative postulates for EEG desynchronization phenomena.

- 442 Gibson, D., & Hall, M. Cardiovascular change and mental task gradient. Psychonomic Science, 1966, 6, 245-246.

Twenty-four Ss in 2 groups engaged in 3 intensity dimensions and 2 duration dimensions of problem solving for a Lacey type "silent elaboration" task. One group performed under a white-noise environment and the other under a silent environment. The results indicate that contrary to general expectation, difficult mental tasks are associated with less heart-rate acceleration than easy mental tasks. These findings obtain under the white-noise condition only. The results are considered in relation to the Lacey formulation and arousal theory.

- 443 Glanzer, M., Chapman, R. M., Clark, W. H., & Bragdon, H. R. Changes in two EEG rhythms during mental activity. Journal of Experimental Psychology, 1964, 68, 273-283.

Two sets of tasks — mental addition tasks and concept tasks — were given to 12 Ss and the effects of these tasks on 2 EEG rhythms kappa and alpha — observed. On the mental addition tasks the difficulty of the task was shown to increase the output of kappa significantly but not the output of alpha. On the concept task, however, the difficulty of the task was shown to depress the output of alpha significantly. The results for kappa, although highly consistent for each individual, did not show any consistent pattern from 1 individual to another. It was suggested that the effects of mental tasks on kappa and alpha are specific to the sense modality involved in the task.

- 444 Glass, A. Mental arithmetic and blocking of the occipital alpha rhythm. Electroencephalography & Clinical Neurophysiology, 1964, 16, 595-603.

The relation of EEG blocking induced by mental arithmetic to the latency and correctness of response has been investigated in 58 Ss by a method of measuring intensity of blocking based on the rate of change of potential (r.c.p.). Errors in arithmetic were associated with a high r.c.p. before and during the task. Long latencies were generally associated with low r.c.p. but Ss who blocked intensely responded rapidly. These results were interpreted in terms of EEG mechanisms which may participate in the control of behavior.

- 445 Glass, A. Comparison of the effect of hard and easy mental arithmetic upon blocking of the occipital alpha rhythm. Quarterly Journal of Experimental Psychology, 1966, 18, 142-152.

The intensity of blocking of the alpha rhythm of the EEG induced by the solution of 5 hard mental multiplications was compared with the intensity of blocking induced by 5 easy ones in 36 normal Ss. Two apparently conflicting hypotheses were examined: (1) blocking would be more intense in the hard tasks, if their solution required increased mental concentration, and (2) insofar as "higher thought" processes are more extensively required in the solution of hard tasks, then blocking would be less intense in hard tasks than in easy ones. It was found, however, that blocking was of the same intensity in tasks of both kinds. Hard tasks differed from easy ones with regard to the relation of EEG changes and performance. It is thought that different mechanisms may underlie the solution of the 2 types of task.

- 446 Glass, A. Intensity of attenuation of alpha activity by mental arithmetic in females and males. Physiology and Behavior, 1968, 3, 217-220.

The EEGs of normal men and women have been compared by measuring the effects of mental arithmetic on alpha activity. A pre-recorded male voice posed 20 multiplications and additions while alpha prevalence with eyes closed was registered automatically, before (alpha 1), and during (alpha 2), calculation. Average alpha 2 in females was significantly lower than in males by 19.1 per cent. Alpha 1 of males (67.1 percent) was higher than in females but the ratio alpha 2/alpha 1 declined significantly in females. Thus the intensity of attenuation of alpha activity to the same problems was greater in women than men. Hormonal or psychological causes for these findings are discussed in the light of earlier studies and their significance is assessed in relation to possible differences in cerebral function between male and female.

- 447 Glass, A., & Kwiatkowski, A. W. Power spectral density changes in the EEG during mental arithmetic and eye-opening. Psychologische Forschung, 1970, 33, 85-99.

The effect of mental arithmetic (standard multiplication, with eyes closed) and eye-opening on the power spectral density of the EEG (recorded bipolarly from occipital and parietal regions) have been compared. The EEG was recorded on magnetic tape from normal subjects, (medical students) in a constant environment and subsequently analysed by an analogue computer (Noratom Instrument for Statistical Analysis and Computation, ISAC).

Absolute measurements made from 15 subjects with eyes closed have shown that peaks of power at 10 Hz vary from 9 to 46 μV^2 , per Hz. Qualitatively, suppression of power at 10 Hz is greater due to eye-opening than mental arithmetic.

Analysis of pooled power spectral density functions from 11 subjects showed that the effect of eye-opening differed significantly from the effect of mental arithmetic at 2.5 and 12.5 Hz. Suppression of lower frequency alpha activity was more pronounced during calculation than during eye-opening. Compared with the eyes closed condition, eye-opening showed a highly significant suppression at 10 and 12.5 Hz (alpha activity) and from 15 to 25 Hz (beta activity). Mental arithmetic induced significant suppression at 7.5 and 10 Hz and from 15 to 30 Hz. Eye-opening enhanced lower frequency activity which calculation suppressed.

Variation was greater between first, second and third calculations in pooled power spectral densities than between corresponding eye-opening epochs. It is suggested that these differences in effects of eye-opening and mental arithmetic reflect differences in underlying cerebral activity, rather than that an underlying factor common to both effects may be orbital in origin.

- 448 Godaert, G., Kok, A., van Hechten, H., & Driehuis, H. J. De invloed van feed-back van reaktie-tijden op de reaktie-tijd, "expectancy wave" (CNV) en hart-frekwentie: Specifieke en niet-specifieke effecten. [The reflexive influence of the feedback of reaction time, "expectancy wave" (CNV) and heart-frequency: Specific and nonspecific effects.] Nederlands Tijdschrift voor de Psychologie en haar Grensgebieden, 1973, 28, 369-388.

Studied the influence of feedback on the attending processes. Ss were 36 16-31 yr old male candidates for the air service. The effects of the feedback were varying length of the reaction time (RT), the "contingent negative variation" (CNV), and the variation in heart frequency. The CNV, measured by EEG, indicated the reaction during the preparatory interval between the warning signal and the reaction signal or button-pressing. The CNV was characterized by the rapid ascent of the EEG during the preparatory interval and a rapid reduction succeeding the reaction signal. A strong deceleration in heart frequency was associated with a strong CNV amplitude and a short RT. The conditions were no feedback, random feedback, and constant feedback. With random or constant feedback the CNV rose but fell with no feedback. Results indicate no difference between the average CNV amplitude of 2 groups of quick or slow reactors. Different effects of the feedback conditions on the amplitude of the CNV were found for the varying lengths of the preparatory interval. Also the length of the preparatory interval influenced the contour of the CNV.

- 449 Goff, W. R. Evoked potential correlates of perceptual organization in man. In C. R. Evans and T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

In summary, I have reviewed the 'state of the art' with regard to the neuropsychology of evoked responses relevant to perceptual organization in general, and attention in particular. I have made some suggestions for further refinement of methodology in the interpretation of more consistent results from different laboratories. I have discussed the problem of devising independent measures of the effectiveness of operations designed to alter attention. I have suggested that attention, at least in its relation to evoked potentials, be viewed in the perspective of one end of a continuum along which the neurophysiological correlates of consciousness and the psychological correlates of perceptual organization co-vary. Finally, I have reviewed evidence suggesting that late evoked response components, most frequently measured in attention experiments, may not reflect activity mediated by an independent extralemniscal projection system as previously thought, but appear to be dependent on the integrity of the lemniscal system at the thalamocortical or cortical level. They may result from, or be generated by, activity in commissural structures and function in the interhemispheric transfer of sensory information, or they may subserve still more complex processes of perceptual organization and memory. I think it highly desirable that conceptualization of future attention-evoked response experiments consider possible neural bases for and functional significance of the electrical signals being measured. Determining that certain evoked response components change in relation to what we define as alterations in attention is only the first step toward the goal of specifying the neural mechanisms which permit the biological adaptation of selecting and attending to relevant stimuli while suppressing other sensory input.

- 480 Goff, W. R., Matsumiya, Y., Allison, T., & Goff, G. D. Cross-modality comparisons of averaged evoked potentials. In E. Donchin & D. B. Lindsley (Eds.), Average evoked potentials: Methods, results, and evaluations. Washington, DC: US Government Printing Office, 1969.

In summary, we have discussed the problems encountered in an extensive cross-modality experiment, which we believe are of general relevance to the conduct of any such study. We believe that the predominant need for cross-modality comparisons and indeed for all AEP studies is development of standardized techniques so that the work of different laboratories may be compared directly and accurately, thus minimizing overlap and duplication of effort. To this end, we have suggested that the general use of bipolar recording, especially in the absence of adequate consideration of placement, introduces confusion and retards progress in AEP research. We have indicated a common nonscalp reference location that appears to be relatively indifferent for evoked activity in all three modalities. We have suggested the need for uniformity of measurement and of component nomenclature and suggested a system which, while we do not expect its adoption as such, we hope may serve as a basis for achieving agreement. We have attempted to illuminate the question of sources of variability in AEPs and suggested that this is intimately related to the serious problem of "contamination" of scalp-recorded AEPs by extracerebral generators. On the basis of homogeneity in focus and distribution among subjects, we have designated AEP components that appear to be of cerebral neurogenic origin and indicated electrode locations for the three modalities that are likely to record them without serious distortions from extracerebral sources. These locations suggest another possible basis for standardization.

We have adapted the hypothesis that the neural substrates of sensory information processing in the auditory, somatic, and visual system operate in similar ways and should thus produce homologous AEP components. Such homologies are more likely to become apparent when we have minimized spurious technical variability.

- 481 Goldstein, H. S., Pardes, H., Small, A. M., & Steinberg, M. D. Psychological differentiation and specificity of response. Journal of Nervous & Mental Disease, 1970, 151, 97-103.

Investigated empirically the relationship between field dependence and specificity of physiological response by use of a visual attending task which elicited directional fractionation. GSR and heart rate were recorded from 10 field-independent (FI) and 10 field-dependent (FD) undergraduates before and during a visual attending period which consisted of looking for brief periods at a small light. Results are summarized as follows: (a) directional fractionation of response was demonstrated for all 20 Ss, (b) the GSR activity of FD Ss was at a higher level during the resting period than the FI Ss, (c) the GSR activity of the FI Ss showed a larger rise during the attending period than the FD Ss, and (d) the heart rate deceleration was larger for the FI Ss than for the FD Ss.

- 482 Goldstein, L., Burdick, J. A., & Lazzio, M. A quantitative analysis of the EEG during sleep in normal subjects. Acta Physiologica Academiae Scientiarum Hungaricae, 1970, 37, 291-300.

EEG time-course variability was analyzed on 8 adults. The EEG from left and right parietal leads was recorded and analyzed from unfiltered amplitude measurements using electronic integrators. Variability levels were estimated from values of the cumulated amplitudes in successive 10-second intervals. EEG variability was lowest during wakefulness and highest during S-4. During REM it was above wakefulness. Correlations of variability levels between left and right leads were highest during S-4 and lowest during REM.

- 483 Golubeva, E. A., & Rozhdestvenskaya, V. I. O sootnoshenii proizvol'nogo zapominaniya i nekotorykh psikhofiziologicheskikh pokazatelei. [The relationship between voluntary remembering and some psychophysiological indices.] Voprosy Psikhologii, 1969, 15, 48-59.

The present work was devoted to the comparison of the efficiency of long 4-hour memorization of 150 three digit numbers with the subjects' psychophysiological indices. The following indices were used: visual sensitivity, the indices of induction technique, critical frequency of flicker fusion, critical frequency of sound clicks fusion, the skin resistance level, characteristics of the skin galvanic response, the speed of conditioning and differentiation, alpha-rhythm frequency, the summary energy of delta-, theta-, alpha-, beta-1, beta-2 bands, photo-driving, the latency of rhythmic motor reactions, the duration of rhythmic motor reactions in EMG and voluntary rhythm. These indices permitted the authors to determine typological properties -- strength, lability, dynamism of excitation and inhibition as well as to obtain characteristics of voluntary reactions. It was established that the subjects with good as well as with poor efficiency of voluntary memorization do not differ significantly by these psychophysiological indices which are the characteristics of typological properties. It was, however, found that in subjects who memorized better the latency and the duration of EMG reactions to rhythmic flashes were shorter, and the fall of the orienting GSR was "steeper". These findings are accounted for by the higher level of activation reactions and by the better verbal, voluntary regulation of memorization in subjects who memorized better.

- 484 Goodman, D. M. The effect of oculomotor activity on alpha-blocking in the absence of visual stimuli. Psychophysiology, 1976, 13, 462-465.

One within-subjects experiment employing 20 normal adults was performed to examine the effects of controlled eye movements in the dark on occipital EEG alpha. The subjects moved their open eyes laterally toward tones coming from 5 different loud speakers on a perimeter, in the dark. The amount of alpha recorded from each subject during his eye movements locating the auditory stimulus was compared with the amount of alpha recorded during the control condition of eyes open in the dark with tones coming from the perimeter of speakers, but with no eye movements. Visual input remained constantly zero during both conditions. Significantly more alpha-blocking occurred during the eye movement condition than during the no eye movement control condition (rejection region=.95). Subsequent tests supported this finding for each of the 5 eye and loudspeaker positions. The results indicate that a visual stimulus is not necessary to produce suppression of alpha, but that controlled oculomotor adjustments are sufficient.

- 486 Gorbov, F. D., Matova, M. A., & Rozenblat, B. S. K kharakteristike psikhicheskikh sostoyanii cheloveka v uslozhennykh usloviyakh deyatelnosti. [The nature of the mental state in man during complex conditions of activity.] Voprosy Psikhologii, 1971, 17, 88-9.

Ss were given the task of adding numbers that appeared on a moving polygraph tape. At times, the task was complicated by a voice counting, by tape speedup, or by requiring S to change to a different method of addition. S's GSR, EKG, and EEG were simultaneously recorded on the tape. The introduction of stressful changes led to different reactions in different Ss, in some, it interrupted the task for a time; in others, it affected performance adversely while improving it in the remaining Ss. Performance changes coincided with changes in the physiological measures taken.

- 488 Gorbunova, L. N. Opyt psikhofiziologicheskogo issledovaniya effektivnosti razlichnykh form cheredovaniya truda. [A psychophysiological investigation of the effectiveness of different forms of task alternation.] Voprosy Psikhologii, 1968, 14, 21-26.

Work efficiency was studied in assembly line workers performing a simple, monotonous production task. One group of Ss performed this task without alternating it with other tasks, another group alternated it with 2 other tasks during a work day, and a 3rd group alternated the 3 tasks on a weekly basis. Variability in time required to manufacture an item, pulse rate, and the rate of information processing in a control task were measured. While pulse rate did not discriminate between groups, variability in production time was greater in the monotonous group, where it also increased during the course of the day, no change being noted in the groups with task alternation. The rate of information processing declined toward evening in the monotonous group, remaining constant in the 2 alternation groups. A study of the nature of the tasks suggests that, in addition to monotony, task complexity is an important factor which affects work efficiency depending on the order in which different tasks follow each other.

- 487 Graham, F. K., & Clifton, R. K. Heart-rate change as a component of the orienting response. Psychological Bulletin, 1966, 65, 305-320.

Both Sokolov and the Laceys have proposed that autonomic feedback to central neural structures amplifies or reduces the effects of stimulation. Lacey and Lacey distinguished between the effects of feedback from the cardiovascular system and from other autonomic systems and suggested, specifically, that heart-rate (HR) acceleration should be associated with stimulus "rejection" and HR deceleration with stimulus enhancement. This appeared to be contradicted by evidence that HR increased with the orienting reflex whose function according to Sokolov, is the enhancement of stimulus reception. However, when studies using simple "nonsignal" stimuli were reviewed, it was found that the criteria identifying an orienting reflex were satisfied by responses of HR deceleration and that instances of HR acceleration probably reflected a "defense," "startle," or "acoustic-cardiac" response.

- 400 Grandjean, E. Etude de la fatigue chez des employes occupees a des travaux requerant de la vigilance. [A study of fatigue of workers employed on tasks requiring vigilance.] Actes du Troisieme Congres de la Societe d'Ergonomie de Langue Francaise, Bruxelles: Presses Universitaires de Bruxelles, 1968, 207-211.

This study examined the relationship between critical flicker frequency (CFF) and performance. No correlation was found between subjective feelings of fatigue or performance on the one hand and CFF on the other. The author speculates that the vigilance required in the class of occupations studied was accompanied by stimulation at the level of the central nervous system which suppressed fatigue during work through the mediation of the reticular activating system.

- 400 Grandjean, E., Baschera, P., Martin, E., & Weber, A. The effects of various conditions on subjective states and critical flicker frequency. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

In laboratory and field conditions the CFF values show a common trend with subjective statements of "fatigue", "sleepiness" and similar sensations.

Repetitive tasks with very low mental loads induce a decrease of CFF and a shift of subjective feelings towards "fatigue", "sleepiness" and a lower degree of "motivation" and of "ability for action".

Activities with a moderate mental load induce in the beginning an increase of CFF, which afterwards remains on about the same level. These activities seem to be an optimal working condition producing only small subjective and objective symptoms of fatigue.

Activities with high mental loads induce -after a first stimulating period - a decrease of CFF with a shift of subjective feelings towards "fatigue" and "exhaustion". We assume that these changes reveal a state of fatigue due to an excessive demand on the central nervous system.

- 400 Grandjean, E., & Kogi, K. Introductory remarks. In K. Hashimoto, K. Kogi & E. Grandjean (Eds.), Methodology in human fatigue assessment. London: Taylor & Francis, 1975.

In the light of present neurophysiological knowledge we may consider fatigue as a state of the central nervous system induced by a prolonged activity and fundamentally controlled by the antagonistic activity of the activating and inhibitory systems of the brain stem. The regulating systems in turn are susceptible to reaction to stimuli from the surrounding world, to stimuli from the conscious part of the brain, and to humoral factors originating within the organism and having obviously the task of regulating recovery and wakefulness.

Another important aspect of fatigue is that an advanced state of fatigue leads to deterioration of physical and mental performance and causes various unfavourable symptoms. This indicates that the assessment of observed behavioural as well as psychophysiological data must be relevant to an 'unacceptable' stage of fatigue.

Some investigations in human beings, which were discussed at the Kyoto Symposium and which are published in this monograph, gave results matching well this neurophysiological concept of fatigue. Significant correlations were found between changes characteristic of general level of alertness and psychophysiological changes, and between psychophysiological performances and subjective feelings of fatigue.

We may therefore conclude that by looking for psychophysiological changes associated with performance decrement it is possible to propose procedures adequate for measuring fatigue related to work load and to monotony. Special attention should be paid to the requirement of 'detail and synchrony' of measurements. Important as well in assessing the observed data is to reach a general agreement concerning the safe marks of the early stage of fatigue.

We hope the Kyoto Symposium has contributed to a better understanding of the psychophysiological mechanisms and of the various symptoms of fatigue which gain importance in our modern world of increasing mental demands.

- 401 Grandjean, E. P., Wotzka, G., Schaad, R., & Gilgen, A. Fatigue and stress in air traffic controllers. Ergonomics, 1971, 14, 159-165.

Fatigue was measured on 68 air traffic controllers using the following methods: critical fusion frequency (CFF), tapping test, grid tapping test, self-rating. The measurements were taken 9 times within 24 hours over 3 weeks. Stress was measured on the basis of a questionnaire and of catecholamine excretion in urine. The four fatigue tests showed significant agreement. There was a marked decrease in the values after the 6th hour of work. During the night hours, the test values were lower, and the subjects stated they were more tired. For the first work hour and for the 9th to 11th work hour Spearman's correlation coefficients between the two sets of data were calculated. A significant correlation was found (a) between CFF and grid tapping ($p < 0.02$); (b) between CFF and self-rating 'refreshed-tired' ($p < 0.05$); (c) between grid tapping and self-rating 'refreshed-tired' ($p < 0.02$). This means that subjects with a marked decrease in CFF or in grid tapping performance have a greater tendency to 'tired' in the self-rating test. On the basis of this finding it might therefore be hypothesized that all measures are indicative of a common state of fatigue.

Results of the questionnaire (62 subjects): in difficult situations 60 subjects felt nervous, tense, irritated, 13 were anxious and trembling, 19 had increased perspiration, 14 had increased pulse rate and heart rate, 25 suffered from insomnia and chronic fatigue.

Urine samples from 6 subjects were taken after normal office work, easy ground control work, and radar air traffic control. There was a significant increase in the catecholamines in the last condition.

- 402 Granger, L. Variation de la fréquence cardiaque dans différents types de situations d'attention visuelle. [Variation of heart rate in different types of visual attention situations.] Canadian Journal of Psychology, 1970, 24, 370-379.

Recorded heart rate of 30 male undergraduates in 3 different experimental situations. In the 1st, Ss looked at certain visual stimulations. In the 2nd, Ss pressed a lever when a specific stimulation was presented. In the 3rd, Ss pressed a lever when a specific stimulus was presented but were told that they would receive an electric shock on the left arm if they did not do it at a certain speed. Results suggest that the explanation of increase in heart rate proposed by J. I. Lacey in terms of "rejection of the environment" by the organism is limited to certain types of situations.

- 463 Grant, J. S. Concepts of fatigue and vigilance in relation to railway operation. In K. Hashimoto, F. Kogi, & E. Grandjean (Eds.), Methodology in human fatigue assessment. London: Taylor & Francis, 1975.

Considerable advances in biochemical and physiological research have recently made it possible to show that fatigue in train driving exists, even though drivers on modern locomotives do not expend much physical energy.

On British Railways a number of detailed heart-rate recordings have been taken from drivers during normal duty runs. These tend to confirm the findings, but to apply this knowledge to practical counter measures it is necessary to find the sources of the fatigue.

In order to analyse the skills required to perform the task, it is proposed to use methods of continuous observation of fine details of overt human behaviour, together with records of physiological measurements and events outside the locomotive cabin. Preliminary work on these lines shows that fatigue in drivers may arise, not from overloading the human system but from underload or monotony due to prolonged inaction combined with stress.

A monotonous environment leads to sensory adaptation and hence to reduced absorption of information. One of the main purposes of further study is to find out what environmental information the driver acts upon and to what extent he relies on his memory of the track. This would lead to the points in time and space at which information processing begins to deteriorate. It is necessary to understand this to specify the particular aspects in the driver's environment which should be enriched so that vigilance is improved and the onset of fatigue averted.

- 464 Greene, R. L., Dengerink, H. A., & Staples, S. L. To what does the terminal orienting response respond? Psychophysiology, 1974, 11, 639-646.

Previous authors suggested that the electrodermal orienting response to stimulus onset (OR) reflects cognitive processes related to the content of a stimulus while responses to stimulus offset (TOR) reflect processes related to stimulus duration. Experiment 1 tested the hypothesis that the OR and TOR are special cases of Ss responding to whatever part of the stimulus contains information necessary to make the requested judgment. The results clearly supported this alternative hypothesis. The Ss responded to stimulus onset when asked to judge the pitch (content) of a constant tone and to stimulus offset when asked to judge the terminal pitch of a varying tone. They responded to both the onset and offset of a stimulus when asked to compare the onset and offset pitch and when asked to judge stimulus duration. Experiment 2 partially replicated Experiment 1 in an attempt to assess the OR-TOR phenomenon in a second sensory modality (vision) and with a second dependent measure. The patterns of both electrodermal and heart rate responses were similar to those of Experiment 1 and to those observed by other authors.

- 466 Greene, R. L., Kille, S., & Hogan, F. A. Electrodermal measures of attention and effort to stimulus onset and offset. Psychophysiology, 1977, 14, 79. (Abstract)

Physiological measures of both tonic and phasic levels of arousal are thought to vary directly with the attention and/or effort required by the task. In a test of this hypothesis, electrodermal measures of tonic and phasic arousal were examined to four levels of task difficulty at stimulus onset and offset.

Forty female and 40 male college undergraduates served as subjects. The stimuli, which were presented for 10 sec, consisted of one of two tones and one of two hues of slides. The pair of light and tone was constant for each student across all 18 trials with a variable inter-trial interval.

There were four experimental conditions. In the nonsignal condition, the students were asked to sit quietly and observe the stimuli. In the other three conditions, the interval between stimuli onset or offset was constant at 2.0, 0.2, or 0.02 sec. Within each condition the students were instructed to determine either which stimulus came on first or went off first.

There were more frequent and larger amplitude skin conductance responses as the discrimination became more difficult at both stimulus onset and offset. However, skin conductance responses were consistently more frequent and larger to stimulus onset than stimulus offset. The frequency of spontaneous GSRs increased exactly as the difficulty of the discrimination, but was not significant because of the large variance in these responses. Basal skin conductance level did not reliably differentiate the four conditions.

Phasic levels of arousal accurately reflected the difficulty of the discrimination to both stimulus onset and offset. Tonic levels of arousal reflected minimally, if at all, the difficulty of the task.

- 466 Griesel, R. D., & Clark, H. M. S. The relation of indicators of arousal in the evoked response to attentional factors in cognitive test performance. Psychologia Africana, 1974, 15, 101-110.

Sixty-six Bantu mine-worker recruits were classified into three groups of differing cognitive ability on the basis of their performance on the General Adaptability Battery of the National Institute for Personnel Research. Visual and auditory evoked responses were recorded and the three groups compared with regard to their level of arousal as reflected by the amplitude of the evoked response and their variability in arousal as expressed by the standard deviation of evoked response amplitude scores. Though variability of amplitude and rate of habituation of the evoked response could not be shown to differ for the three groups a possible inverted-U relation between cognitive performance and arousal level was found which would suggest that arousal may be an important correlate of cognitive process.

- 467 Griew, S., Davies, D. R., & Treacher, A. C. C. Heart rate during auditory vigilance performance. Nature, 1963, 200, 1026.

It is difficult on the basis of the results of this work, in which only eight subjects participated, to draw any reliable conclusions about individual differences in detection ability and their prediction; but the significant correlation between cardiac lability and total error score suggests that heart rate variability may be a predictor of vigilance performance, although it seems unlikely that it will efficiently predict commissive errors in performance.

- 468 Grim, P. F., & White, S. H. Effects of stimulus change upon the GSR and reaction time. Journal of Experimental Psychology, 1965, 69, 276-281.

Sixty Ss were given 16 RT trials using a colored light as stimulus and then, without warning, lights differing in color but not in intensity were presented. Augmented GSR reactions occurred as a monotonic function of amount of change. Lengthened RTs were also observed; the amount of such lengthening did not appear to be simply related either to evoked GSR or to amount of stimulus change.

- 469 Groll, E. Experimentelle Untersuchungen über Zusammenhänge zwischen Aufmerksamkeit, Vigilanzleistung und Aktivierungsvorgängen. [Experimental studies on the relations between attention, vigilance performance and activation processes.] Unpublished doctoral dissertation, University of Vienna, 1963. (Cited in D. P. Kimble (Ed.), Readiness to remember. New York: Gordon and Breach, 1969)

- 470 Groll, E. Zentralnervöse und periphere Aktivierungsvariable bei Vigilanzleistungen. [Central and peripheral activation variables in vigilance performance.] Zeitschrift für experimentelle und angewandte Psychologie, 1966, 13, 248-264.

EEG, ECG GSR, and records of muscle vibrations during a test of visual vigilance were recorded and served as indicators of central and peripheral activation. Observed and overlooked signals could be distinguished from the activation patterns. However, different activation variables showed different, partly antagonistic tendencies, so that the concept of "general activation" during observations must be rejected.

- 471 Groll-Knapp, E. Evoked potentials and behaviour. In W. Singleton, J. Fox & D. Whitfield (Eds.), Measurement of man at work. London: Taylor & Francis, 1971.

The electrical activity that can be recorded from the surface of the human head, the so-called electroencephalogram (EEG) has been used, apart from its clinical application, in psychophysiological studies. This ongoing or spontaneous rhythmic activity of the brain may be used among other things as an indicator of the arousal state of the organism but at the same time it masks the more specific brain responses. Such EEG responses evoked by different stimuli constitute an important group of phenomena for the neurophysiologist as well as for the psychologist. The method of acquisition of such so-called evoked potentials and our knowledge about their interpretation have reached a state of development where it seems justified to add this method to the other physiological methods which are used to find better strategies for man-machine design. In this paper I will briefly summarize the common techniques and then give some examples of application in vigilance studies, attention and expectation studies; studies on basic time relations in sensory motor interactions and investigations on communication problems especially concerning the gnostic discrimination ability.

- 472 Gross, E. G., Vaughan, H. G., Jr., & Valenstein, E. Inhibition of visual evoked responses to patterned stimuli during voluntary eye movements. Electroencephalography and Clinical Neurophysiology, 1967, 22, 204-209.

Evoked cerebral responses were recorded to brief shifts of patterned stimuli under conditions of constant luminous flux during voluntary eye movements and ocular fixation. Virtually complete suppression of evoked response and perception of the pattern shift occurred during eye movements. In contrast, much dimmer test flashes presented against a dark field were suppressed to a substantially lesser degree. Retinal blur was eliminated as a factor in saccadic suppression, since inhibition was the same for horizontally and vertically oriented patterns. The results indicate that an inhibitory mechanism must exist which is specific for contour shift as opposed to change in luminance.

- 473 Gross, M. M., Begleiter, H., Tobin, M., & Kissin, B. Auditory evoked response comparison during counting clicks and reading. Electroencephalography and Clinical Neurophysiology, 1965, 18, 451-454.

The shift from a casual task directed away from auditory stimuli to a task requiring a low order of effort directed to the auditory stimuli produced significant changes in the 4 major amplitudes and the total duration of the auditory evoked response.

- 474 Grossman, R. W., Fitzgerald, H. E., & Porges, S. W. Sex and preparatory interval differences in responding forearm activity during a simple reaction time task. Psychophysiology, 1971, 8, 268-269. (Abstract)

Both groups had faster reaction times in the fixed preparatory interval conditions than they had in the variable interval conditions. This supports the view that both groups were able to develop temporally conditioned preparatory responses facilitative of faster reaction time. Here the somatic expectancy response most associated with best performance for one sex was associated with the worst performance for the other sex. The males who had the highest levels of forearm circumference change by the last second of the preparatory period had the fastest reaction times, while the females with the lowest levels of change had the fastest reaction times. This suggests that the male nervous system is helped most by a different type of expectancy response than the female nervous system. The male response, as an increase in muscle tension level before the onset of the reaction signal that is related to performance, has traditionally been treated as motor preparation (Woodworth & Schlosburg, 1965; Titchner, 1954; Freeman, 1933; Davis, 1940; Duffy, 1962). It seems reasonable to suggest that male RT performance is therefore most facilitated by an enhancement of a motor response. This increase of muscle contraction before signal onset might be thought of as having an "hair trigger" effect in building tension to the point where the slightest disturbance of any kind will trigger the response.

It is somewhat more difficult to view the inhibition of contraction before signal onset, which is most facilitative of female performance, as motor preparation. In fact, motor inhibition has been associated with enhancement of perception (Woodworth, 1938; Obrist, 1970). This response might be thought of as reducing the amount of distracting sensory excitation to allow one to more completely focus one's attention to the signal light.

- 475 Grunewald, G., Simonova, O., & Creutzfeldt, O. D. Differentielle EEG - Veränderungen bei visuomotorischen und kognitiven Tätigkeiten. [Differential EEG - alterations during visuomotor and cognitive tasks.] Archiv fuer Psychiatrie und Nervenkrankheiten, 1968, 212, 46-69.

The EEG's of precentro-central (PC) and occipito-temporal (OT) areas were recorded with telemetry, and their changes during 6 standardised visuomotor and 2 cognitive tasks were compared with the EEG during rest with open eyes. Automatic EEG analysis on the principle of zero-crossing and interval analysis was used. The EEG changes during tasks differed significantly in the PC and OT areas. Furthermore, they were dependent on individual factors (type of resting EEG with the eyes open) and on characteristics of the tasks. On the other hand, they were not correlated with the degree of attention or concentration involved in the performance of each task, as assessed by each subject using the method of comparison of pairs.

In the frequency class of 8.5–12.5/sec, a significant decrease in the number of waves was seen during all tasks in the PC areas, but in the OT areas an increase or decrease was seen in different individuals: a higher degree of decrease (blocking) was found when the resting EEG showed many alpha-waves during rest (eyes open), a smaller degree of decrease or even increase (alpha-activation) was seen when the resting EEG showed a low alpha-rate during rest. In the frequency range of 12.5–16.0/sec the OT-EEG showed an increase during all tasks, while no effect was seen in the PC-EEG's. Waves between 6–8.5/sec did not show a significant change during the tasks.

After eliminating the influence of the resting EEG by calculation (regression analysis), a differentiation between EEG reactions to different tasks became more evident. The PC alpha-rate showed the least decrease during cognitive tasks, while the OT alpha-rate showed the highest tendency towards activation during maze drawing with direct or mirror image control. The occipital beta-activation was lowest during writing without visual control.

- 476 Gulian, E. Contributii la studiul mecanismelor neurofiziologice ale atentiei: IV. Efectele excitatiilor proprioceptive asupra potentialelor evocate prin stimuli luminosi intermitenti. [Contributions to the study of neurophysiological mechanisms of attention: IV. The effects of proprioceptive stimulations on evoked potentials by intermittent photic stimulation.] Revista de Psihologie, 1965, 11, 427-436.

Effects of proprioceptive stimulation, which occur during motor reactions in producing and maintaining attention, were studied on the EEG. Proprioceptive stimulation is dynamogenic, facilitating the integration of sensory messages in dependence on the functional state of the nervous system.

- 477** Gulian, E. Effects of noise on EEG latency changes in an auditory vigilance task. Electroencephalography and Clinical Neurophysiology, 1969, 27, 637. (Abstract)

Latency of alpha blocking to correct detections (CD), false alarms (FA) and missed signals (MS) was investigated under different types (continuous and intermittent) and intensities (70 dB and 90 dB) of noise, the first experiment being performed in conditions of quiet. The subjects (15) had the task of detecting a signal among 4 other acoustic stimuli which appeared randomly, at irregular intervals. EEG was recorded continuously from the T-O and T-T leads, during the whole session (1 h 30 min). It was found that: (1) the latency of CD is shorter than that of FA and MS under all experimental conditions; (2) the mean latency of CD and FA varies (decreases) mainly as a function of the type of noise and only secondarily of its intensity (in continuous noise the latency is greater than in intermittent noise); (3) the longest EEG latencies for all performance indicators were recorded in the course of weak continuous noise. It is suggested that differences in background noise elicit variations in mean latency scores for each category of indicators, but that the general level of latencies (longer or shorter) is determined by the response type. Thus, background noise exerts an unspecific influence which mainly induces changes in the cerebral tone, whereas a task, which implies continuous attention, has a predominantly specific arousing effect.

- 478** Gulian, E. Some electroencephalographic correlates of auditory vigilance in noise. Revue Roumaine des Sciences Sociales: Serie de Psychologie, 1970, 13, 167-178.

Analysis of EEG modifications during an auditory vigilance task in noise points to their dependency according first of all to the type of noise and only subsidiary to its intensity. Thus, various intensities of background noise do not produce significant differential modifications of arousal level. On the other hand, evaluation of type of noise effects shows that intermittent noise evokes higher arousal level than continuous noise, this hyperarousal having — according to interindividual differences — either decremental or incremental effects on signal detection.

Statement of individual differences in cerebral reactivity towards noise, corresponding to differences in performance level, thus suggests that the differentiated changes of the cerebral tone under noise influence determine variations in the level of operational vigilance.

- 479** Gulian, E. Correlats psychophysiologiques de la decision dans une epreuve de vigilance auditive. [Psychophysiological correlatives in decisions during an auditory vigilance test.] Revue Roumaine des Sciences Sociales: Serie de Psychologie, 1970, 14, 17-29.

Despite their relative simplicity, analysis of vigilance tests reveal complex mental processes dealing with attention, perception, and decision. The 2 most common errors in a vigilance task is nondetection of signals, or an individual's overconfidence in his inability to commit an error. In a research conducted on 15 individuals, it was noted that the percentage of omissions and incorrect detections varies little with various noise levels, but that the former exceeds the latter by almost double. It is affirmed that utilization of various indicators confirms the existence of differences in the certainty of detection of critical signals and that noise has a direct bearing on cerebral activity, thus contributing to the elevation or the reduction of assuredness in decisions pertaining to a vigilance task.

- 480** Gulian, E. Effects of noise on arousal level in auditory vigilance. Acta Psychologica, 1970, 33, 381-393.

Changes in arousal level (cerebral reactivity) expressed through EEG parameters were followed up simultaneously with performance in auditory signal detection under different noise conditions. It was stated that Ss differ in respect to their cerebral reactivity, ranging in a continuum from hyperreactivity to hyporeactivity. Exposure to noise elicits alterations in arousal level; hyporeactive Ss are aroused, whereas the hyperreactive Ss are de-aroused. Statistically significant differences were found between number of omissions of the two groups under most experimental conditions. Number of detections varied only slightly in hyporeactives, but described an inverted-U relation as a function of noise in hyperreactives.

- 481** Gulian, E. Auditory vigilance under noise conditions: Psychophysiological correlations. Studia Psychologica, 1971, 13, 114-120.

Studied the effects of noise upon auditory vigilance and its physiological concomitants in 15 19-30 yr olds during 5 experimental sessions. Performance measures (RTs, GSRs, and EEGs) were recorded. Modifications of behavioral vigilance and the other indicators under quiet and different levels (70 and 90 db) and types (continuous and intermittent) of noise were investigated. Results indicate a certain dissociation between EEG, GSR, and behavioral activation, but the concordance of all measures varied as a function of the degree of stress.

- 482** Gulian, E. Psychophysiological correlates of auditory vigilance under noise conditions in introverts and extraverts. Revue Roumaine des Sciences Sociales: Serie de Psychologie, 1971, 15, 125-136.

Attempted to determine whether different kinds of noise exert a differential effect on vigilance performance and autonomic reactivity as a function of personality. Seven verbal stimuli, meaningful trigrams, were embedded in irrelevant stimuli and presented randomly at time intervals ranging from 30 sec to 2 min under conditions of quiet (15 min) followed by high- and low-noise conditions (60 min). Based on scores on the Eysenck Personality Inventory, 6 introverts, 6 extraverts and 8 ambivalent Ss were tested and their performance and GSR measures recorded. It was found that introverts made more errors in quiet than in noise, whereas the opposite was true for extraverts. Extraverts showed more noise tolerance on the GSR measure. Increase in autonomic arousal was associated with performance in introverts only.

- 483** Gulian, E. Corelate psihofiziologice (vegetative) ale vigilentei auditive in conditii de zgomot. [Psychophysiological correlates of auditory vigilance in noise.] Revista de Psihologie, 1972, 18, 41-51.

A comparison of heart rate values showed that the detection of signals in noisy conditions does not produce changes in the heart rate but that anticipation of intermittent noise increases it. The variability of heart rate would appear to be related to personal differences in the subject. It is suggested that the quickening of the heart rate demonstrates the raising of the level of alertness.

- 484 Gullickson, G. R., & Darrow, C. W. Contingent negative variation modified by respiratory phase. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 295-297.

If inspiration and expiration are favorable to different cortical effects, as suggested here, a methodological consideration is implied for investigators who employ shock, near-threshold signals, or any other situation which might result in the occurrence of systematic differential respiratory patterns. If these results are confirmed, respiratory phase should be considered as a variable to be controlled in CNV studies.

- 485 Guttmann, G. Hirnelektrische korrelate einfacher wahrnehmungen das akustisch evozierte potential als abbild psychischer prozesse. [Cerebral electrical correlates of simple perception.] Studia Psychologica, 1968, 10, 200-213.

Presented a sequence of objectively unchanging acoustic stimuli (clicks) to 13 Ss who by pressing buttons had to estimate the value of each click after it had sounded. Each S experienced subjective vibrations of the intensity and considered some individual stimuli as quieter or louder. The EEG, stimulus-synchronous triggering-pulses, and estimates of intensity of Ss were recorded throughout the experiment. The acoustically evoked potential was determined. Discrepancy between the objective and subjective changes in intensity of stimuli revealed that certain components of the acoustically evoked potential do not represent the stimuli but the experience itself and may, therefore, be considered the biological basis of experienced process.

H

- 486** Haas, K. A. The use of palmar skin conductance and palmar skin resistance as predictors of task performance (Doctoral dissertation, Rensselaer Polytechnic Institute, 1968). Dissertation Abstracts, 1969, 29, 2896B. (University Microfilms No. 69-2459)

Briefly, activation theory predicts an inverted U relationship between level of performance and level of activation, i.e., there is a level of activation over which task performance is optimal. Unfortunately, the work of activation theorists has been limited primarily to psychologically oriented tasks. It appears that if activation theory is valid for tasks of an industrial nature (psychomotor tasks), then psychophysiological measurements could be used in lieu of subjective performance ratings. A hand-arm serial psychomotor task was designed, and two experiments one utilizing industrial workers, the other, students, were conducted. A detailed analysis of the experimental results indicated that the measurements, as commonly used by other experimentalists, did not provide any significant subject-by-subject results; nor did they support activation theory.

The results and analysis of this experiment indicate that the range of arousal embodied in activation theory is much too large for application to industrially oriented tasks. The belief is that the adjusted scales developed in this study may be used in certain industrial situations where monitoring is required such as testing, methods evaluations and learning studies. Since the subject-by-subject correlations were not significant for all subjects, we conclude that the new scales are not suitable as a replacement for subjective performance ratings.

The analysis of the data indicated areas where further research would be beneficial. Specific recommendations are presented and discussed in some detail.

- 487** Hahn, W. W. Attention and heart rate: A critical appraisal of the hypothesis of Lacey and Lacey. Psychological Bulletin, 1973, 79, 59-70.

Evaluates the hypothesis concerning attention and heart rate formulated by J. Lacey and B. Lacey [in P. Black (Ed.), Physiological Correlates of Emotion, 1970] with respect to its original and subsequent expressions, its testability, and research results offering confirmation or disconfirmation. Heart-rate deceleration occurs in a variety of situations including many that require attention to the environment, but support for the instrumental role of this reaction in actively facilitating certain kinds of sensory-motor performance is lacking. The major contributions that are needed for the hypothesis to retain its heuristic value are (a) clarification of constructs, e.g., "attention," and greater explicitness of several aspects of the hypothesis; (b) less reliance on heart rate alone as a dependent measure reflecting mediating mechanisms and cortical effects; and (c) more investigation of other hypothesized mediating mechanisms.

- 488** Haider, M. Aktivierung, aufmerksamkeit und leistung. [Activation, attention and performance.] In F. Merz (Ed.), Bericht über den 25 Kongress der deutschen Gesellschaft für Psychologie Munster, 1966, 160-162.

Investigated activation and attention in an undefined population using vigilance tests. Measurement indices included EEGs, evoked potentials, and pulse. Results showed that attention and lack of attention were demonstrable. A hierarchical system of activation was formulated which included these categories: (1) the psychophysiological sleep-waking mechanism, (2) generalized tonic activity, (3) localized activation, and (4) differentiated and selective activation.

- 400 Haider, M. Vigilance, attention, expectation and cortical evoked potentials. Acta Psychologica, 1967, 27, 246-252.

Computer-averaged evoked potentials were recorded to flashes and clicks from subjects performing vigilance tasks as well as tasks requiring selective attention, expectation and anticipation. Fluctuations in vigilance performance were accompanied by corresponding changes in evoked potentials. Missed signals showed lower evoked response amplitudes than detected signals. During selective attention responses were larger when attention was directed toward the stimuli. In the expectation studies an 'expectancy potential' could be demonstrated at the instants when the stimulus was expected but did not actually occur. On the other hand, the prominent negative peak of evoked responses appeared later, if the stimulus occurred earlier than expected.

- 400 Haider, M., Ganglberger, J. A., & Groll-Knapp, E. Thalamo-cortical components of reaction time. Acta Psychologica, 1969, 30, 378-381.

There is some indication that the amplitude of contingent negative variations is larger with faster reaction times (Grey Walter et al. 1964; Irwin et al. 1966; Hillyard and Galambos 1967), thus linking the slow brain potential changes to the problems of experimental reaction time studies. Our results demonstrate for the first time the involvement of subcortical centers. They show especially a prominent thalamic potential during almost the whole time between imperative signal (second click) and reaction. The duration and form of this thalamic motor potential suggest that the central components of reaction time may be mainly made up by nervous activities in the higher centers of motor afferences to the cortex and subsequent thalamocortical interactions. Whereas the mere afferent and efferent conduction times constitute only a small fraction of the whole reaction time, the described complex sensory-motor interactions at different levels of central regulation are responsible for the main part.

- 401 Haider, M., & Groll, E. Vigilanzleistungen, vigilanzausfalle und ihre neurophysiologischen korrelate. [Levels of vigilance, drops in vigilance levels, and related neurophysiological correlates.] Proceedings of Second International Congress on Ergonomics, Dortmund, 1964, 221-222.

The drop in alertness over a period of time correlated with the reduction in the amplitude of cortical response with $r=+0.75$ and with an increase in the latency period of $r=-0.75$.

The evaluation criteria showed a clear difference in the amplitudes of cortical response with respect to detected light signals compared with the potential following undetected light signals by the test subjects. Amplitude values were higher with respect to the potential following the signals detected by the test subjects. Results were widely distributed but in all instances fell in the same direction.

- 402 Haider, M., Spong, P., & Lindsley, D. Attention, vigilance, and cortical evoked-potentials in humans. Science, 1964, 145, 180-182.

Computer-averaged potentials evoked from the cortex were recorded to nonsignal stimuli and to randomly interspersed signal stimuli requiring detection and response during prolonged visual vigilance. As detection efficiency diminished over time, the amplitude of evoked responses to nonsignal stimuli decreased and latency increased. Fluctuations in vigilance (attentiveness) during the course of the task also were accompanied by corresponding changes in evoked-potentials to nonsignal stimuli. More specific lapses of attention, revealed by detection failures, resulted in average evoked-responses of lower amplitude to missed as compared with detected signals.

- 403 Haider, M., Spong, P., & Lind, D. B. Cortical evoked potentials during visual vigilance task performance. Electroencephalography and Clinical Neurophysiology, 1964, 17, 714. (Abstract)

As vigilance fluctuated and waned during the course of the task, amplitude and latency of the evoked potentials to the neutral stimuli showed corresponding variations. Amplitude was reduced and latency increased during periods of lowered performance efficiency.

These results show a close correspondence between electrophysiological and behavioral data in a vigilance task requiring perceptual discrimination and response. Thus fluctuations in vigilance or attention appear to be reflected in the changes of cortical evoked potentials.

- 404 Hanna, T. D. A physiologic study of human subjects confined in a simulated space vehicle. Aerospace Medicine, 1962, 33, 175-182.

The effect of eight days confinement on four bioelectric measures of six men while monitoring a Vigilance Work Station in a simulated space capsule was presented and discussed. Under the conditions of the experiment, it was concluded that the significant differences which occurred in the four physiologic functions (heart rate, respiration rate, forehead skin temperature, and plantar electrical skin conductance) recorded were due to anxiety-provoking stimuli, rather than the confinement per se. The interpretation of physiologic measures is discussed.

- 405 Harding, G., & Punzo, F. Response uncertainty and skin conductance. Journal of Experimental Psychology, 1971, 88, 265-272.

Phasic and tonic skin conductance were measured in three experiments with human Ss where stimuli varied in (a) presence or absence of a response associate, (b) type of response associate (pay attention vs. make a skeletal response), and (c) amount of response uncertainty evoked. Stimuli accompanied by skeletal responses evoked larger autonomic responses than did stimuli without response associates at the same level of response uncertainty, but larger autonomic responses were emitted to stimuli evoking greater response uncertainty regardless of skeletal response accompaniment. Skin conductance varied directly with amount of skeletal response uncertainty but was invariant and reliably lower over response uncertainty levels for Ss instructed to pay attention. Amount of response uncertainty determined rate of phasic skin conductance habituation, not initial response magnitude as suggested by Berlyne.

- 406 Harding, G. B., Stevens, E. E., & Marston, P. T. Rate of information processing and skin resistance. Journal of Experimental Psychology, 1973, 99, 306-313.

Presented an information reduction task to undergraduates (N = 180) in 2 experiments. Ss were instructed to gate (i.e., ignore) 3, 2, 1, or 0 tone dimensions prior to response selection within the stimulus durations of .5, 1, or 4 sec. Dependent variables were the mean phasic change in skin resistance, mean response time, and amount and rate of information transmission associated with each of the 12 conditions. The mean phasic skin resistance change associated with each group was considered to be a function of the (a) presence or absence of the choice motor responses, (b) amount of motivation as measured by tonic skin resistance, (c) degree of skeletal response conflict, and (d) rate of information transmission in bits/sec. Rate of information transmitted accounted for more variance (95%) than any other variable.

- 407 Hare, R. D. Cardiovascular components of orienting and defensive responses. Psychophysiology, 1972, 9, 606-614.

Data from an earlier study of physiological responses to affective visual stimulation were reanalyzed in an attempt to delineate the cardiovascular components of the OR and the DR. A HR response profile to unpleasant stimulation was obtained for each of 49 Ss by computing his average beat-by-beat HR response to slides of homicide victims. A hierarchical grouping procedure was then used to group these profiles in terms of similarity. An optimum grouping of three distinct groups of profiles emerged. Group A consisted of 9 Ss whose HR responses were accelerative in nature, Group D of 12 Ss who gave marked decelerative responses, and Group MD of 28 Ss who gave moderate decelerative responses. The cephalic vasomotor response given by Group A to the homicide slides was vasoconstriction, while the response of Groups D and MD was vasodilation. The results provide some support for the suggestion that the OR consists of HR deceleration and cephalic vasodilation, while the DR consists of HR acceleration and cephalic vasoconstriction. However, it is possible that these "classic" patterns of cardiovascular activity occur in only some Ss and only under certain conditions, and that they may be obscured by the use of undifferentiated group data.

- 408 Hare, R. D. Response requirements and directional fractionation of autonomic responses. Psychophysiology, 1972, 9, 419-427.

Physiological responses were monitored while 27 male Ss were shown a series of 45 colored slides of homicide victims. Nine of the Ss were required to simply look at each slide (Nonraters), 9 were required to push 1 of 7 buttons, after each trial to indicate how disturbing they found the slide to be (Raters). Evidence for directional fractionation of autonomic responses to the slides was obtained for only the Nonraters. Their responses included cardiac deceleration, an increase in skin conductance, digital vasoconstriction, and cephalic vasodilation. The Raters responded with cardiac acceleration, and increase in skin conductance, and both digital and cephalic vasoconstriction. The Raters also showed a larger increase in tonic skin conductance over trials than did the Nonraters. To determine whether the physiological responses of the Raters were influenced by the requirement to make a motor response, 9 other Ss pressed a button after each slide. The physiological responses of these latter Ss were almost identical with those of the Nonraters.

The results are consistent with the hypothesis that the requirement to rate the stimuli was associated with appraisal and cognitive elaboration. They also indicate that response requirements can have a profound effect upon autonomic responsivity.

- 409 Hare, R., Wood, K., Britain, S., & Shadman, J. Autonomic responses to affective visual stimulation. Psychophysiology, 1971, 7, 408-417.

Physiological responses were recorded while 48 male Ss viewed a series of 30 slides of homicide scenes, nude females, or ordinary objects. Half the Ss saw the same slide 30 times while the others saw a different slide on each trial. The physiological responses given by all six groups involved were those generally associated with an OR—increase in skin conductance, cardiac deceleration, and digital vasoconstriction. In addition, a biphasic cephalic vasomotor response, consisting of constriction followed by dilation, was observed. Stimulus presentation was also accompanied by a sharp reduction in eyeblink rate.

The physiological and eyeblink responses given by Ss who saw a different homicide scene on each trial were generally greater and more resistant to habituation than were those given by other Ss. Ss repeatedly shown the same homicide scene gave relatively small cardiac and cephalic vasomotor responses, and showed rapid habituation of the electrodermal response.

- 800 Harkins, S. W. Aspects of the psychobiology of attention: Visual evoked potentials and performance in a task demanding sustained attention (Doctoral dissertation, The University of North Carolina at Chapel Hill, 1974). Dissertation Abstracts International, 1975, 36, 471B-472B. (University Microfilms No. 75-17, 646)

Three studies have evaluated the relationship between performance, evoked potentials and time in the session. In only one case do the results lend support to the model that habituation of cortical evoked potentials is related to decrements in performance. The present research was designed to evaluate the relationship between changes in performance and cortical evoked potentials during a paced continuous performance task. Evoked potentials and performance were examined as a function of time on task and signal regularity using a within-subjects design. Thus, it was felt a stronger test of the neural habituation hypothesis was possible.

Detection decrement occurred as a function of time and signal regularity but was not paralleled by changes in evoked potential amplitude or latency that could be related to the neural habituation hypothesis. The most consistent change in sensory evoked potentials paralleled time in sessions but not performance. Implications for further research are discussed.

- 801 Harkins, S., et al. Evaluation of a continuous performance task by age, sex, and time-on-watch. Paper presented at the 25th Annual Science Meeting of the Gerontological Society, San Juan, Puerto Rico, December 1972.

Men and women (forty-five to seventy; $n=328$) were exposed to a continuous performance task consisting of 1-digit numbers (1-9) presented 1/sec. The task was of 10 minutes duration. Ss were instructed to press a key whenever an even number followed an even or an odd followed an odd. These critical events occurred in random order with a mean frequency of 1 : 6 numbers. Ss were divided into five 5-year age groups. Percentage correct detections, false positives, responsivity (correct detections + false positives), reaction time, and heart rate were evaluated by multivariate analysis. Reaction time increased with age. Percent correct detection did not vary with age although the age by sex interaction was significant for false positives and responsivity. In the oldest group (sixty-five to seventy) men decreased in these two measures while women increased. Independent of age or sex, false positives, responsivity, and percent correct detections declined with time-on-watch in a manner analogous to the performance decrement observed in many vigilance tasks. Reaction time and heart rate increased with time-on-watch for all age groups.

- 002 Harms, C. B. The differential effect of induced muscular tension and task difficulty on digit identification and selected physiological measures (Doctoral dissertation, Temple University, 1967). Dissertation Abstracts, 1968, 28, 4311B-4312B. (University Microfilms No. 68-4510)

The present research was designed to investigate the joint effects of experimentally induced muscular tension and task difficulty upon a perceptual identification task, and upon selected measures of physiological activity.

An attempt was made to obtain more direct evidence for the notion that induced muscular tension exerts its effects on performance by increasing activation level. Performance under different induced muscular tension conditions was measured. Concomitant physiological indices that define activation were also used. If the activation hypothesis is correct, increasing induced muscular tension should be accompanied by increasing efficiency of performance until a point is reached, beyond which, performance begins to decline with increasing tension. Physiological activity, however, should continue to increase as muscular tension increases.

One-hundred-twenty subjects were used in a 4x5 factorial design. Four muscular tension conditions were used. A specially constructed hand dynamometer was used to induce muscular tension at 1/4, 1/2, and 3/4 of the subjects' maximum squeeze, determined on a preliminary test. The fourth level was no dynamometer tension. The task was identification of series of digits presented in a tachistoscope. The number of digits presented was varied at five levels, presentation of no digits, five, six, seven, and eight digits. Measures of respiration rate, pulse rate, and skin conductance were made on a Stoelting Deceptograph.

Results showed:

1. Skin conductance increased significantly with increases in induced muscular tension for all digit levels, and also for that group of subjects which were not required to identify digits. Increase in pulse rate as a function of increased muscular tension approached the $p = .05$ level of significance. Respiration rate was not significant.
2. The number of digits correctly identified as a function of induced muscular tension approached the $p = .05$ level of significance. The relationship between digits and muscular tension was cubic.
3. Pulse rate increased significantly as the number of digits exposed increased. Neither respiration rate nor skin conductance varied significantly as a function of the number of digits exposed increased.
4. The number of digits correctly identified decreased significantly as a function of the number of digits exposed increased.

- 803 Harris, D. A., Hale, H. B., Hartman, B. O., & Martinez, J. A. Oral temperature in relation to inflight work/rest schedules. Aerospace Medicine, 1970, 41, 723-727.

Six experimental flying missions (each of 54 hours duration) were flown in a C-141 aircraft. Two crews took turns flying the aircraft during each mission. The same two crews flew all six missions. In three of the missions the work/rest schedule was 4/4 hours; in the remaining missions it was 16/16 hours. Oral temperatures of 9 of the crewmembers (2 aircraft commanders, 2 co-pilots, 2 flight engineers, 2 navigators and 1 loadmaster) were measured at 4-hour intervals during the flight periods and also during 54-hour postflight periods, with the testing schedule standardized with respect to time of day. The oral temperature rhythm during flight periods, although remaining entrained to the time at the home base, was lower in amplitude than that during postflight periods ($P < .01$). The 4/4 work/rest schedule had more depressant influence on oral temperature than the 16/16 schedule ($P < .005$). Crew position was found to be a factor contributing to oral temperature variability ($P < .05$). The individuals occupying key positions had the lowest oral temperatures during flight periods as well as during postflight periods.

- 804 Harris, W. Fatigue, circadian rhythm, and truck accidents. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

Most truck accidents occur because of driver error, and many likely are the result of failures in vigilance performance. The truck driving task requires the driver to maintain a continual vigil if he is to perform successfully. Truck drivers often drive for long hours at a time and at all times of the day and night, conditions that expose them to the effects of fatigue and circadian rhythms. Fatigue and circadian effects on vigilance performance are well-established. The purpose of the analyses reported here was to see if such effects were present in truck accidents which seemed to be the result of failures in vigilance performance.

Interstate truck accident data provided by the Bureau of Motor Carrier Safety of the U. S. Department of Transportation were analyzed for three groups of drivers: dozing drivers, those who had had single-vehicle accidents, and those who had crashed into the rear end of other vehicles. The effect of fatigue was confirmed for each of the groups: fewer accidents than expected occurred early in trips and more than expected later in trips; about twice as many accidents occurred during the second half of trips than during the first half, irrespective of trip duration. The circadian effect was observed for dozing drivers; about twice as many of their accidents occurred between midnight and 8:00 a.m. than in the other 16 hours of the day, and for single-vehicle accident drivers, about half of their accidents occurred in the early morning hours. The circadian effect was not as marked for other-vehicle accident drivers, likely because of variations by time of day in the number of vehicles on the road.

There is some evidence of a combined effect of fatigue and circadian rhythm on the relative likelihood of occurrence of accidents.

- 505** Harris, W., & Mackie, R. A study of the relationships among fatigue, hours of service, and safety of operations of truck and bus drivers (1727-2). Goleta, California: Human Factors Research, Incorporated, 1972. (NTIS No. PB 213-963)

The relationships among fatigue, hours of service, and safety of operations of truck and bus operators were investigated through (1) a critical review of research pertaining to driver fatigue and alertness; (2) an opinion survey of professional drivers and transportation industry officials concerning current practices and regulations related to hours of service; (3) an analysis of accident data from several major carriers from the viewpoint of possible fatigue-related causes; and (4) an empirical investigation of the effects of hours on the road, rest breaks, type of operation, time of day, and driver age on certain measures of driver performance and physiological states associated with fatigue and alertness.

- 506** Hart, J. D. Physiological responses of anxious and normal subjects to simple signal and non-signal auditory stimuli. Psychophysiology, 1974, 11, 443-451.

In an attempt to assess orienting (OR) and defensive responses (DR) of anxious and normal Ss, heart rate (HR) and skin conductance (SC) changes were measured in response to three intensities of signal and non-signal tones. Anxious Ss significantly differed from normal Ss in the number of spontaneous SC responses emitted, but did not differ in either magnitude or rate of habituation of SC responses to the tones. An analysis of second-by-second changes in HR suggested that, relative to normal Ss, anxious Ss show a deficit in OR and a greater tendency to respond with a pattern characteristic of a DR. This difference was particularly apparent under signal conditions.

- 507** Hart, J. D. Cardiac response to simple stimuli as a function of phase of the respiratory cycle. Psychophysiology, 1975, 12, 634-636.

To evaluate respiratory effects on the cardiac response to simple stimuli, 10 female subjects were presented with a series of 20 100 dB tones with stimulus onset occurring at either peak expiration or peak inspiration. The heart rate response at peak inspiration is quartic in form (deceleration-acceleration-deceleration-acceleration) and differs significantly from that obtained at peak expiration which is cubic in form (acceleration-deceleration-acceleration). These differences can be eliminated, however, by subtracting heart rate values obtained during control periods from the heart rate response to stimulation.

- 508** Harter, M. R., Eason, R. G., & White, C. T. Effects of intermittent visual input disruption, flicker-rate, and work time on tracking performance and activation level. Perceptual and Motor Skills, 1964, 19, 831-848.

The effects of flicker-rate (0 to 24 cps) on rotary tracking performance and physiological "indicators" of activation level were studied under two conditions of background illumination (illuminated and non-illuminated). During the illuminated condition the target was visible between flashes (continuously), whereas during the non-illuminated condition it was visible only during the flash. Muscle tension of the neck and forearm flexor muscles, skin conductance, and heart rate were used as indicators of activation level. Tracking performance varied significantly with flicker-rate and illumination level. During the illuminated condition, performance decreased then increased as flicker-rate increased, the low point being at about 9 cps. During the non-illuminated background condition, performance increased rapidly as flicker-rate was increased up to 9 cps. Further increases had relatively slight effects on tracking performance. The physiological indicators remained essentially constant when flicker-rate was varied, indicating no change in activation level. The performance data were interpreted in terms of a "psychological moment" model.

- 509 Harter, M. R., & Salmon, L. E. Intra-modality selective attention and evoked cortical potentials to randomly presented patterns. Electroencephalography & Clinical Neurophysiology, 1972, 32, 605-613.

The effects of selective attention on visually evoked cortical responses (VERs) were investigated under conditions where transient changes in arousal level and peripheral orienting factors were reduced to a minimum. Four subjects were presented a random series of relevant and irrelevant light flashes and were instructed either to count or to make a reaction time response to the relevant stimulus. Stimuli were presented at a constant rate of 0.92 or 1.92 c/sec. Subjects fixated a central reference point on the stimulus screen throughout each trial. Averaged VERs from the occipital region showed a consistent increased negativity at latencies of 220-250 msec and positivity at latencies of 290-340 msec when the stimulus was attended as compared to not attended. The effects of attention on VERs did not differ significantly as a function of the response conditions or rate of stimulus presentation. The effects of selective attention on early and late evoked cortical activity were discussed in terms of the processing of sensory information in the peripheral and central nervous system, respectively.

- 510 Harter, M. R., & White, C. T. Perceived number and evoked cortical potentials. Science, 1967, 156, 406-408.

Evoked cortical potentials and the number of flashes perceived were compared when subjects were presented with short trains of flashes under conditions where each presented flash could not be counted individually but the train of flashes appeared to be flickering (1 to 14 flashes at 33.3 flashes per second). The rate at which each successive perceived flash was added appeared to correspond with the rate at which the successive components of the evoked response pattern were added. The temporal nature of this pattern was similar both for single flashes and trains of flashes. The results suggest that the onset of stimulation triggers a process which has a marked effect on both the cortical and perceptual response to subsequent stimulation.

- 511 Hartley, L. R. The effect of stimulus relevance on the cortical evoked potentials. Quarterly Journal of Experimental Psychology, 1970, 22, 531-546.

Investigated the relationship between selective attention and the cortical evoked potentials and avoided some methodological artifacts. Twelve 21-65 yr. old Ss were divided into auditory and visual signal detection groups. Each group was required to detect infrequent signals of 1 modality in a random sequence of auditory and visual stimuli. Results provide no direct support for the postulated correlation between the 2 variables, but do suggest 2 possible explanations.

- 512 Hartman, B. O., Storm, W. F., Vanderveen, J. E., Vanderveen, E., Hale, H. B., & Bollinger, R. R. Operational aspects of variations in alertness. (AGARD-AG-189). Brooks Air Force Base, TX: USAF School of Aerospace Medicine, Aerospace Medical Division, August 1974. (NTIS No. AD-786 123)

Variations in alertness undoubtedly affect operator performance, sometimes to a degree which significantly degrades operational effectiveness. Alertness is a biological state with behavioral, neurophysiological and biochemical elements. Related states are vigilance, attention, and arousal. This monograph summarizes the literature on these topics, as well as the influence of various environments on alertness levels, spontaneous fluctuations in alertness, and effects of such variation on operator performance. The environments under consideration include long duration flights, flights at night, monotonous tasks, solitude, mild hypoxia, and variations in thermal conditions in a flight compartment.

- 513** Hasbrook, A. H., & Rasmussen, P. G. Pilot heart rate during in-flight simulated instrument approaches in a general aviation aircraft (AM 70-7). Oklahoma City, Oklahoma: Office of Aviation Medicine, Civil Aeromedical Institute, April 1970. (NTIS No. AD-711268)

Eight instrument rated pilots with flying experience ranging from 600 to 12,271 hours each flew 10 simulated ILS instrument approaches in a single engine, general aviation aircraft equipped with a primary flight display arranged in a conventional "T" configuration. Continuous heart rate data were recorded during each approach. Approaches were flown consecutively at approximate 10-minute intervals, with a 1-minute in-flight rest period prior to each approach. Principal findings were: heart rate increased significantly during each approach; mean increase in heart rate during the approaches was 5.2 beats per minute (BPM) and was of a relatively constant magnitude for each of the 10 approaches; and the overall mean heart rate level decreased on successive approaches for a total of 11.0 BPM for the 10 approaches. The results are discussed in terms of responses to stress introduced by the demands of the task.

- 514** Haske, R. Das Verhalten der Tagesrhythmik von Körpertemperatur und Leistung nach zwei Transatlantikflügen in rascher Folge. [Behavior of circadian rhythm of temperature and performance after two subsequent transatlantic flights.] Unpublished doctoral dissertation, Bonn University, Germany, 1974.

Circadian rhythms of temperature and performance were studied in 8 students in 3-hour-intervals during periods of 24 hours after a jet flight from Germany to USA and vice versa with a stay of 24 hours in the USA. Two 24-hour preflight periods revealed the basic normal daily rhythm of temperature and performance. The effects of a 6 hour time shift after the 24-hour stay in the USA were evaluated by determining temperature and performance parameters on day 1, 3 and 5 following the flights. A considerable desynchronisation with the local time was observed after flights. The resynchronisation-time amounted up to 3-5 days in Germany afterward.

- 515** Haslum, M. N. Psychophysiological correlates of activation in vigilance. Unpublished doctoral dissertation, University of Exeter, 1976. (Cited by A. Gale, Some EEG correlates of sustained attention. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.)

- 516 Haslum, M. N., & Gale, A. Inter-modal and intra-subject consistency in EEG correlates of vigilance. Biological Psychology, 1973, 1, 139-150.

Occipital EEG was monitored continuously for 20 subjects who took part in an auditory vigilance task and for 20 in a visual vigilance task. Ten subjects were common to both experiments. The two tasks were virtually identical. EEG samples were taken for each of 250 signal presentations. Automatic low frequency analysis was performed on 4 frequency bands between 2.0-19.5 cps. There were 5 types of signal in the task and each signal was followed by a rest period. The wanted signal was 4 consecutive odd and different digits. The other signals contained either 3 odd and 1 even digit, 2 odd and 2 even digits, one odd and 3 even digits or 4 even digits. Since the 5 signal types varied in their approximation to the wanted signal they were ranked on that criterion for their arousal value. There were a number of statistically significant findings as follows. A decreasing monotonic trend is demonstrated for EEG abundance across signal types, that is, EEG abundance is inversely proportional to the arousal value of the signal for both the auditory and the visual tasks. Subjects common to the 2 tasks show consistency of individual differences in the 2 EEG trends across the tasks. EEG alpha and beta abundance provide strong evidence for individual differences in the magnitude of abundance under different stimulus conditions. Subjects with faster median reaction times demonstrate a stronger EEG trend than those with slow reaction times. However, reaction time is not related to either pre-, during or post-signal presentation EEG. A decreasing monotonic trend is demonstrated for post-test subjective ratings of alertness for each signal type and also for the associated rest periods in both the auditory and the visual task. The trend in the subjective ratings for signals agrees with the trend in EEG abundance. Subjects are consistent in their ratings across the 2 tasks.

- 517 Hastrup, J. L. Electrodermal lability, introversion, and vigilance decrement. Psychophysiology, 1977, 14, 111. (Abstract)

Previous studies have suggested that two electrodermal measures (frequency of spontaneous fluctuations in skin conductance and rate of electrodermal orienting response habituation) predict individual differences in vigilance decrement. Other studies suggest that Eysenck's measure of introversion also predicts vigilance decline. The present study examined the performance of subjects selected on both electrodermal and introversion measures under two conditions of task difficulty.

Subjects were 80 men, half of whom were assigned to each task condition. Subjects were instructed in the procedure for reporting detections of infrequent auditory signals. After a practice period, a 48-min vigilance task was administered, followed by an introversion questionnaire.

The results indicated that the electrodermal measures predicted vigilance decrement over time for subjects on the difficult task, but not on the easy task. The introversion variable resulted in insignificant and contradictory findings, contrary to Eysenck's theory.

Although introversion and the electrodermal measures were orthogonal, it was possible to predict differences in performance decrement on both tasks by combining the three measures. These findings suggest that electrodermal lability alone and in combination with introversion scores predicted differences in vigilance decline, but that the electrodermal measures interacted with an environmental variable, task difficulty. Theoretical implications for differences in sympathetic nervous system activity and Eysenck's theory of introversion are discussed.

- 518 Hauty, G. T. Relationships between operator proficiency and effected changes in biological circadian periodicity. Aerospace Medicine, 1963, 34, 100-105.

In consideration of all data, it does seem proper to conclude that certain of the subjects could adapt substantially to a drastic revision of their accustomed sleep-wakefulness cycle or day. In part, at least, this may be attributable to the three conditions earlier mentioned: Environmental control of accustomed circadian cues, rigid commitment to a fixed schedule of work which was accepted by the subjects as a unique challenge to their ability, thereby, in a sense, forcing them to live an 8-hour day, and deliberate exploitation of individual differences. From this, several points of speculation are apparent. One concerns the question of what would happen to the circadian periodic component had confinement been extended to two or more weeks. Another, equally interesting, concerns the full extent of the modifiability of man's biological day.

- 519 Hauty, G. T., & Adams, T. Phase shifts of the human circadian system and performance deficit during periods of transition. Aerospace Medicine, 1965, 36, 148. (Abstract)

At periodic intervals throughout the biological day, assessments were made for a week prior to intercontinental flight yielding a reference of biological time set to the environment of origin, for 2 weeks at the temporally displaced environment of destination which encompassed the period of transition for the "primary" phase shift, and for a week following return to the environment of origin which provided a period of transition for the "back" shift. Assessments made included rectal temperature, heart rate, respiratory rate, palmar evaporative water loss, urinalysis, reaction time, decision time, critical flicker-fusion, subjective fatigue and well-being, and intellectual facility. The intercontinental flights included East-West and West-East with each crossing 6 or more time zones. From the considerable volume of data obtained, there are apparent certain general findings which possess practical implications and which will be reported. In brief, these pertain specifically to such phenomena as the lag time for a shift in phase of a given biological parameter, the degree of synchronization in the shifting in phase of different parameters, and performance deficits associated with these phase shifts. Also to be reported are the differential characteristics of these phenomena manifested during the two different phase shifts, primary and back, and, additionally, the extent of inter-individual differences.

- 520 Hauty, G. T., & Adams, T. Phase shifts of the human circadian system and performance deficit during the period of transition: III. North-South flight (AM 65-30). Office of Aviation Medicine, Federal Aviation Agency, December 1965. (NTIS No. AD 689812)

At periodic intervals throughout the biological day, biomedical assessments were made for a week prior to jet flight to Santiago, for 12 days at Santiago and for a week following return to Washington, D. C. From a comparison of these data with those obtained from the East-West flights and West-East flights, the following conclusions were derived:

- (1) While the East-West and West-East flights effected a primary shift of phase of circadian periodicity manifested by the physiological functions, the North-South flight did not.
- (2) The North-South flight produced a significant increment of subjective fatigue, as did the other two flights.
- (3) Significant impairment of psychological performance produced by the East-West but not the West-East flight was not shown by the North-South flight.

- 821 Hauty, G. T., & Adams, T. Phase shifts of the human circadian system and performance deficit during the periods of transition: I. East-west flight. Aerospace Medicine, 1966, 37, 668-674.

At periodic intervals throughout the biological day biomedical assessments were made for a week prior to jet flight to Manila, for 8 days of layover at Manila and for a week following return to the environment of origin. The data revealed that for the physiological functions assessed time displacement effected a primary shift of phase of circadian periodicity which, for rectal temperature and heart rate, required 4 days for completion and, for palmar evaporative water loss, approximately 8 days. Return back to the environment of origin also effected a shift of phase requiring only 1 day for completion. Behavioral integrity was degraded during the primary period of transition and, to a lesser extent, during the period of transition occasioned by return to the environment of origin but duration of behavioral impairment was much shorter than the lag time of physiological phase shifts.

- 822 Hauty, G. T., & Adams, T. Phase shifts of the human circadian system and performance deficit during the periods of transition: II. West-east flight. Aerospace Medicine, 1966, 37, 1027-1033.

At periodic intervals throughout the day, biomedical assessments were made during the week prior to jet flight to Rome, throughout a 12-day layover in Rome and during the week following return to Oklahoma City. Completion of the primary shift of phase of the circadian periodicity manifested by internal temperature and heart rate required from 4-6 days and 6-8 days, respectively. Increase in subjective fatigue occurred during the primary period of transition and following return to the environment of origin but psychological performance was not impaired to any statistically significant extent during either of these periods. Compared to the time lag of the physiological phase shift, the duration of subjective fatigue was very short. Comparison of these results with those obtained from a previous East-West flight did not reveal striking bidirectional differences save for the possible exception of psychological performance which was significantly impaired in the case of the East-West flight.

- 823 Hauty, G. T., & Smith, F. L. Psychological correlates of physiological circadian periodicity. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

The data to be reported here were obtained from a series of studies designed to appraise the effects of time displacement upon human psychological and physiological functions. In brief, these functions were assessed at periodic intervals throughout the accustomed waking day for two or four alternate days. This provided a base of reference, following which the subjects were transported by jet commercial aircraft across 7-10 time zones to a given destination where they remained for 8-12 days, during which they were subjected to the same schedule of psychological and physiological assessments. Finally, the subjects were returned to the origin of the flight where, again, assessment was made on alternate days for a period of a week.

For this report, the data obtained from the assessment of psychological functions prior to transcontinental flight were analyzed for periodicity and its relationship with the generally stable circadian periodicity manifested by rectal temperature.

- 824 Hazemann, P., & Lille, F. Somatosensory evoked potentials, attention and voluntary self-paced movements. In W. C. McCallum and J. R. Knott (Eds.), *The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain*. Bristol, England, 1973. Bristol: John Wright, 1976.

Summation of component changes clearly demonstrates that the SEP was attenuated by the temporal proximity of a voluntary motor act. This attenuation was greatest in the 220-msec epoch just preceding switch closure.

Modulation of the individual components was generally similar to those of the summated score. Only the late (+240 msec) component failed to reach its minimum just prior to switch closure, while the -130 msec component was the only component which was regularly augmented by the motor activity.

Mechanisms responsible for modulation of the SEP in our experiment are open to speculation. Coquery *et al.* (1972) studied SEPs and motor activity, but obtained somewhat different results. They found an increase in the SEP prior to the onset of electromyographic activity and SEP diminution following contraction when the motor act and stimulus were ipsilateral. When the motor act and stimulus were contralateral the SEP increase persisted during and following the contraction. We have never observed an enhancement of the SEP related to the motor act.

Broughton *et al.* (1949) observed a decrease in the SEP during fist clenching and Dinges and Klingaman (1972) observed an enhancement of the VEP concurrent with 'induced muscle tension'. Karlin *et al.* (1970) observed a variety of AEP variations but could not attribute them unequivocally to the occurrence of a motor response. It may be that attentional orientation to the motor act with concomitant distraction to somatosensory perception should be taken into account. Thus, the S who was required to bar press rhythmically, might have paid sufficient attention to the task to attenuate the SEP in somewhat the same fashion as has been demonstrated for the discrimination task alone. Passive induced motor activity might overcome this problem. In any case, SEP attenuation prior to movement strongly suggests an effect specific to motor activation.

- 826 Heinemann, L. G., & Emrich, H. Alpha activity during inhibitory brain processes. Psychophysiology, 1971, 7, 442-450.

Three studies involving quantitative changes in alpha activity are reported. Sixteen normal volunteers were shown neutral or emotionally provoking words appearing with slowly increasing intensity on a frosted glass pane in a darkened room. A differential reaction was observed, i.e., with emotional words there was a higher alpha percentage from the time before the Ss perceived the light until after they could read the word. In the second study 10 normal volunteers were stimulated with closed eyes for 2-sec periods of diffuse light after the hypnotic suggestion of blindness. Compared with the prestimulus interval there was an average increase in alpha amplitude, whereas the control condition showed the usual alpha decrease during stimulation. In the third study 32 chronic schizophrenic patients were given a Phenothiazine derivative over 3 months after a 2-month placebo period. Ratings of alpha activity as to occipital amplitude, group length, topographical extension, and occurrence in synchronous groups showed a progressive increase from the placebo condition to the third month.

- 828 Heinemann, U. Time variability of slow negative potentials and changes in alpha rhythm. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 125-126.

The purpose of this paper is to report some results on slow negative potentials (SNP) preceding voluntary movements and changes in alpha rhythm during this period.

In our experiments 21 Ss were tested in a "readiness potential" situation. They were asked to press a lever arbitrarily every 5-15 sec in order to release either optical or acoustical stimuli, the latter changing in character, intensity and frequency. In another experimental situation, they inflicted themselves with electrical shocks just above the threshold of pain. The subjects classed the different stimuli as either dull, pleasant or distressing. The experiments included one session in the classical readiness potential situation and one in a CNV situation. The electromyogram, recorded when pressing the lever, was used to trigger the stimuli presentations. The subjects sat in a dark, sound-proofed chamber with their eyes closed. The EEG (time constant = 1.2 sec) was recorded from both hemispheres, either central-mastoid or postcentral mastoid. The EEG and the myogram were stored on a magnetic tape and were available for further computer analysis.

- 827 Helander, M. Vehicle control and driving experience, a psychophysiological approach. Proceedings of the 6th Congress of the International Ergonomics Association, 1976, 335-339.

An instrumented vehicle was used for real-time recording of drivers' physiological characteristics (galvanic skin response, heart rate and muscle activity), steering and braking behavior and vehicle response (speed, distance travelled and triaxial accelerations).

Thirty-three drivers performed test-drives along a 25 km stretch of rural road. Seventeen of the drivers were inexperienced and the rest experienced. Response values of vehicle control variables were similar in both groups, whereas physiological responses displayed large differences. Using multiple regression techniques it is shown that for the inexperienced group, road-traffic situations involving the use of the brake explain most of the variance in the physiological measures. Similarly, the steering response was the most important variable for the experienced group.

GSR seems to be an efficient indicator of the mental effort involved in driving. Control skills develop rapidly whereas the discrepancies in physiological responses indicate the relatively slow development of skills necessary for collecting the relevant information.

- 828 Helper, M. M. The effects of noise on work output and physiological activation (Report No. 270). US Army Medical Research Laboratory, Fort Knox, Kentucky: Psychology Department, October 1956. (USAMRL Project No. 6-95-20-001, S-3)

No difference was found between performance scores obtained in noise and in quiet. Skin conductance was higher when the task was performed in noise than when the task was performed in quiet. During the Task-Noise condition, one hour in duration, skin conductance showed no tendency to revert to the non-noise level. These findings suggest that the presence of noise during a task situation may result in increased activity of the sympathetic branch of the autonomic nervous system.

All 3 physiological variables indicated that noise alone was less stressful than noise and task combined. Muscle tension was greater during performance of the task in quiet than during exposure to the noise in the absence of the task. These findings indicate that noise alone (of the intensity used) is relatively non-stressful when compared to performing a difficult mental task under noise, and possibly less stressful than performance of the task alone.

Good performance on the task during noise was more closely related to good performance in quiet than to any physiological measure. However, high skin conductance in noise and short pulse interval (high heart rate) in quiet were significantly associated with good performance under noise. Short pulse interval in quiet was also associated with good performance in quiet. Deterioration of performance during an hour session was associated with slowing of the heart rate (increase in pulse interval) during that time, whether or not noise was present. No relationship was found between any of the physiological variables and changes in performance attributable specifically to noise.

Largely on the basis of the measurements of skin conductance, it is concluded that although noise alone (of 110 db) was relatively non-stressful and although the presence of noise did not produce a significant change in performance, noise does add slightly but significantly to the stressfulness of mental work.

- 829 Heninger, G. R., McDonald, R. K., Goff, W. R., & Sollberger, A. Diurnal variations in the cerebral evoked response and EEG. Archives of Neurology, 1969, 21, 330-337.

The present study was undertaken to determine the relationship between diurnal changes in circulating corticotropin and 17-hydrocorticosteroids (17OHS) levels and the electrical activity of the brain.

Significant morning to evening changes in both the somatosensory and visual evoked responses, as well as in the circulating 17OHS levels, were found. The administration of dexamethasone, which suppressed corticotropin release and imposed a stable 17OHS state, shortened latencies and increased amplitudes in the visual evoked response, but it did not significantly affect the observed diurnal changes in either the visual or somatosensory evoked responses. It is concluded that the observed diurnal variations in electrical activity of the brain are not a function of diurnal changes in either corticotropin release or circulating 17OHS levels.

830 Henry, C. E. Electroencephalographic individual differences and their constancy. II. During waking. Journal of Experimental Psychology, 1941, 29, 236-247.

1. An attempt has been made to determine whether individual differences in the alpha index of the EEG are the reflection of fixed, unalterable and perhaps genetically determined characteristics, or whether these differences may change or perhaps disappear as the individuals are engaged in various types of psychological activities.

2. A wide variety of experimental conditions and a wide variety of subjects have been employed in an attempt to offer opportunity for the appearance (or disappearance) of important changes in the EEG.

3. The percent time alpha has been utilized as the index of the EEG with the realization that it encompasses only one aspect of the total record.

4. What appear to be the most adequate statistical techniques available for the evaluation of such data have been used.

5. Certain conditions of psychological activity coupled with visual stimulation resulted in the reduction of inter-individual differences to the point where they did not significantly exceed intra-individual differences.

6. Inter-individual differences in many conditions, when maintained, were the expression of a different heterogeneity than found under control conditions.

7. It was not possible to predict accurately from this measure obtained under 'standard' conditions, the type and distribution of changes in percent time alpha occurring under other conditions.

8. These findings are considered as offering some support to the hypothesis that a reduction of 'psychological' individual differences may be accompanied by a reduction of electroencephalographic individual differences.

831 Hernandez-Peon, R. Psychiatric implications of neurophysiological research. Bulletin of the Menninger Clinic, 1964, 28, 165-185.

Attention mechanisms, central influences in attention, and the roles of sleep, vigilance and dream systems are among the topics examined neurophysiologically.

- 532 Hernandez-Peon, R. Physiological mechanisms in attention. In R. W. Russell (Ed.), Frontiers in physiological psychology. New York: Academic Press, 1966.

This article reviews research using both human and animal subjects, and covers the following topics:

1. Sensory Inhibition
2. Extrasensory Inhibition
3. Sensory Facilitation
4. Sensory Filtering
5. Classification of Attention
6. Sensory Transmission

- 533 Herrington, R. N., & Schneidau, P. The effect of imagery on the waveshape of the visual evoked response. Experientia, 1968, 24, 1136-1137.

In recent experiments demonstrating changes in the waveshape of the visual evoked response (VER) when a visual form is placed in the visual field, it is not clear whether the change is a direct and inevitable consequence of the patterned distribution of light on the retina in a system for which precise somatotopic localization is claimed, or whether these changes manifest the cellular activities underlying cognition. The experiments reported below suggest that cognitive processes are reflected in the VER waveshape.

- 534 Hess, E. H., & Polt, J. M. Pupil size as related to interest value of visual stimuli. Science, 1960, 132, 349-350.

Increases in the size of the pupil of the eye have been found to accompany the viewing of emotionally toned or interesting visual stimuli. A technique for recording such changes has been developed, and preliminary results with cats and human beings are reported with attention being given to differences between the sexes in response to particular types of material.

- 535 Higgins, J. D. Psychophysiological correlates of attentional processes in humans (Doctoral dissertation, The Pennsylvania State University, 1969). Dissertation Abstracts International, 1970, 31, 2309B. (University Microfilms No. 70-19, 417)

An experiment was carried out to evaluate the relationship of human heart rate and blood volume activity to attentional processes. Analogs of the novelty and signal value variables were manipulated in anticipation of stimulation. These two analogs were defined as "average stimulus uncertainty" and "signal expectancy," respectively. The autonomic activity prior to stimulation was thought to represent tonic attentional variables, while the response to a stimulus (as a function of its novelty and signal value) was thought to represent a phasic orienting response.

The results of this experiment indicated that blood volume activity, while definitely showing changes in anticipation of stimulation, was only minimally related to the tonic attentional manipulations. The blood volume activity was, however, quite sensitive to the stimulus novelty and signal value variables in response to stimulation.

The HR response was basically triphasic in form; the method of computer averaging consistently noted a small deceleration prior to the initial stimulus, then an acceleration, and finally a large prominent deceleration in anticipation of the second stimulus of the contingent pair used. The HR acceleration was shown to be related to stimulus uncertainty, but not to signal expectancy.

The special importance of anticipatory decelerations was pointed out because of their biasing influence on "base" HR measures as generally calculated in psychophysiological investigations. The case of the ubiquitous HR acceleration to non-signal stimuli was discussed as a pertinent example of how anticipatory HR changes can distort apparent HR changes after stimulation.

- 536 Higgins, J. D. Set and uncertainty as factors influencing anticipatory cardiovascular responding in humans. Journal of Comparative and Physiological Psychology, 1971, 74, 272-283.

Human heart-rate and vasomotor activity were monitored while the subjects' expectancies concerning which of two stimuli would occur were manipulated. One stimulus demanded a button-press response while the other required the subject not to respond. In one group this response served merely to detect the response stimulus, while in a second group it was given the added dimension of being a reaction-time response. In both groups cardiovascular activity leading up to stimulus onset was observed to be a function of stimulus uncertainty rather than a simple function of the response stimulus's expectancy. It was concluded that anticipatory cardiovascular responding reflected the attentional requirements of the task rather than simple motor preparation.

- 537** Hillyard, S. A. The CNV and the vertex evoked potential during signal detection: A preliminary report. In E. Donchin & D. B. Lindsley (Eds.), Average evoked potentials: Methods, results and evaluations. Washington, DC: US Government Printing Office, 1969.

Considering these facts, the P300 wave seems to reflect the detection of a stimulus belonging to a particular category, which O is prepared to receive because of its relevance in solving his immediate problems. If O has his attentional "filters" selectively tuned for a particular stimulus configuration, has evaluated its implications, and is set to respond to it accordingly, then that stimulus should evoke a P300 when detected. The CNV would then indicate that the environment is being scanned for a specific, expected stimulus configuration, while the P300 indexes the decision that it has indeed arrived.

If the P300 represents the resolution of uncertainty and a decision, it may be asked why a similar degree of resolution did not occur on the (no/noise) trials. One possibility is that the "no" decisions were not precisely time-locked to the stimuli, so that its P300 referent was not computer-averaged; another is that a negative inference (absence of signal) may be psychologically less decisive than the receipt of positive evidence.

- 538** Hillyard, S. A. Relationships between the contingent negative variation (CNV) and reaction time. Physiology & Behavior, 1969, 4, 351-357.

In a reaction time (RT) test, ten normal adults made lever presses to tones that were preceded by warning clicks. During the preparatory interval between click and tone, a slow negative potential shift (CNV) was recorded from the scalp. The CNV was partitioned into an artifactual component caused by eye movements and a "true" or tCNV, presumably arising from the brain. Over a long series of lever pressing trials, the trial-to-trial variability in tCNV was inversely correlated with the RT of the motor response in half the subjects. The largest tCNVs preceded responses executed with the fastest RTs. These relationships were complex, and the problem of defining the behavioral correlates of the tCNV was discussed.

- 539** Hillyard, S. A. The CNV and human behavior: A review. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 161-171.

Our attempts to conceptualize how the CNV influences the behavioral events which it precedes have been frustrated by two main types of experimental facts. First, CNVs occur in preparation for very diverse types of motor, perceptual and cognitive acts which defy categorization along the lines of traditional psychological variables. Second, the CNV does not in general predict subsequent behavioral performance with a high degree of reliability.

The paradigms in which CNVs are generated may tentatively be classified into four general types (Hillyard 1971): (a) holding a motor response in readiness; (b) preparing for a perceptual judgement; (c) anticipation of a reinforcer, positive or negative; and (d) preparing for a cognitive decision. Rebert (1973 this volume) agrees that either the CNV can be differentiated into a family of task-specific event-related slow potentials, each having a different brain mechanism and functional role, or that it is a manifestation of a unitary process (e.g., arousal) common to all such preparatory acts.

- 540 Hillyard, S. A., Courchesne, E., Krausz, H. I., & Picton, T. W. Scalp topography of the P₃ wave in different auditory decision tasks. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

Sixteen channel mappings of the scalp topography of the late positive P₃ wave were obtained during 5 different decision tasks. All types of P₃s had in common a very broad distribution across the posterior and lateral scalp. There were certain significant disparities in topographies among some of the P₃s, however, indicating that a simple 'unitary P₃' hypothesis may require modification. In addition, the P₃ accompanying detection of a threshold level tone was clearly dissociable topographically from the fall-to-baseline of the preceding CNV.

- 541 Hillyard, S. A., & Galambos, R. Effects of stimulus and response contingencies on a surface negative slow potential shift in man. Electroencephalography & Clinical Neurophysiology, 1967, 22, 297-304.

A slow wave potential was recorded extracranially from 11 Ss during the fixed interval between a warning stimulus (S 1 ; flash of light) and a burst of clicks (S 2) which they terminated by pressing a lever. As Ss learned the fixed sequence S 1 -delay-S 2 -respond, a surface negative potential shift appeared during the S 1 -S 2 interval. Since the magnitude of the shift depended upon the contingent association between S 1 and S 2, it was called contingent negative variation (CNV). When Ss were not required to respond to the clicks, no CNV appeared. When they were told to turn off the clicks, the CNV increased in amplitude at a rate that depended on prior individual experience with the paired flash-clicks contingency. Omission of clicks with no warning to the Ss resulted in gradual diminution of the CNV; subsequent reinstatement of clicks caused the CNV to increase in amplitude again. A significant negative correlation between size of CNV and RT was found over several trials. The relation of the CNV to subjective expectancy and intention to respond was discussed.

- 542 Hillyard, S. A., & Galambos, R. Eye movement artifact in the CNV. Electroencephalography and Clinical Neurophysiology, 1970, 28, 173-182.

During the preparatory interval between a warning click and a tone burst that signalled a lever press, a slow negative potential shift (CNV) was recorded from the scalp in ten normal adults. When the eyes were closed, involuntary eye movements during the click-tone interval consistently generated potential shifts which spread from the corneo-retinal dipole to the scalp electrodes and thereby contaminated the CNV.

The CNV was quantitatively partitioned into an artifactual component caused by ocular rotation (the EAP), which summated with the second component, presumably of cerebral origin, called the "true" or tCNV. The EAP amplitudes were estimated from concurrent recordings of the electro-oculogram. In the average subject, 23% or -6.1 μ V of the total CNV was comprised of EAP, and the EAP often reached from -10 to -15 μ V. The accuracy of the partition was verified by comparing tCNVs recorded with eyes closed and with eyes immobilized by fixation.

The CNV produced during voluntary eye movements was similarly divided into a tCNV, which was tripled in amplitude when ocular responses were made with increased speed and effort, and an EAP, which was determined solely by the amount of ocular displacement.

- 543** Hillyard, S. A., Hink, R. F., Schwent, V. L., & Picton, T. W. Electrical signs of selective attention in the human brain. Science, 1973, 182, 177-180.

Auditory evoked potentials were recorded from the vertex of subjects who listened selectively to a series of tone pips in one ear and ignored concurrent tone pips in the other ear. The negative component of the evoked potential peaking at 80 to 110 milliseconds was substantially larger for the attended tones. This negative component indexed a stimulus set mode of selective attention toward the tone pips in one ear. A late positive component peaking at 250 to 400 milliseconds reflected the response set established to recognize infrequent, higher pitched tone pips in the attended series.

- 544** Hillyard, S. A., Squires, K. C., Bauer, J. W., & Lindsay, P. H. Evoked potential correlates of auditory signal detection. Science, 1971, 172, 1357-1360.

A long-latency component of the averaged evoked-potential recorded from the human scalp varied in close relationship with 3 Ss' perceptual reports in an auditory signal detection task. Detected signals evoked potentials several times larger than did undetected signals, falsely reported signals, or correctly reported nonsignals. The threshold signal intensity at which detection performance exceeded chance levels was identical with concurrently obtained electrophysiological measures of threshold.

- 545** Hink, R. F., & Hillyard, S. A. Auditory evoked potentials during selective listening to dichotic speech messages. Perception and Psychophysics, 1976, 20, 236-242.

The sensitivity of the scalp-recorded, auditory evoked potential to selective attention was examined while subjects monitored one of two dichotically presented speech passages for content. Evoked potentials were elicited to irrelevant probe stimuli (vowel sounds) embedded in both the right-and the left-ear's message. The amplitude of the evoked potential was larger to probe stimuli embedded in the attended message than to probe stimuli in the unattended message. Recall performance was unaffected by the presence of the probes. The results are interpreted as supporting the hypothesis that this evoked potential sensitivity reflects an initial "input selection" stage of attention.

- 546** Hockey, G. R. J., & Colquhoun, W. P. Diurnal variation in human performance: A review. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

This paper has attempted a coverage of the findings on human performance as a function of time of day. A number of fairly clear conclusions can be drawn from these findings: (1) There is a marked rhythm in the efficiency of human performance, both in normal and in many unusual environmental conditions. (2) This rhythm has a primary period of 24 hours, and its effects appear not only when tests are made during the normal waking day, but also when they are carried out through the night. (3) There is a high degree of correspondence between diurnal changes in performance and in body temperature. (4) Adaptation of the temperature rhythm normally occurs within 4-6 days of a changed sleep-waking schedule, usually in the form of a flattening, rather than a phase-shift, and performance tends to follow this adaptation. (5) Task selection is an important aspect of design in diurnal rhythm experimentation, since those tasks with a large memory requirement may give an inverted rhythm. (6) Diurnal variation in performance may be minimised by appropriate instruction of, or special 'effort' on the part of, the subjects employed; and can be masked by the use of an insensitive test of performance. (7) Care must be taken to eliminate or balance all the known major sources of experimental interference in diurnal rhythm studies if the results are to be of real value.

- 647 Hof, M. W. van, The influence of attention on the occipitocortical responses to lightflashes in man. Documenta Ophthalmologica, 1964, 18, 238-244.

Human occipito-cortical responses to intermittent photic stimulation were studied. In the majority of the subjects the most obvious effect of image formation on the flickering screen was amplitude reduction in those components occurring more than approx. 100 msec after the beginning of the flash. It is argued that this effect is caused by the image formation on the retina as such and not by the activity of some "attention mechanism".

In 15 subjects a comparison of the effect of image formation and that of flash-counting was made. In 13 out of these subjects the above mentioned effect of image formation was seen. Only one of these 15 subjects showed systematic changes due to flash-counting, namely an increase of the first negative wave (80 msec after the start of the flash), whereas, image formation in the same subject gave amplitude reduction of later components. This reaction to flash-counting was the only instance where it was necessary to postulate the activity of an "attention mechanism".

- 648 Hof, M. W. van, van Hof-van Duin, J., van der Mark, F., & Rietveld, W. J. The effect of image formation and that of flash-counting on the occipito-cortical response to lightflashes. Acta Physiologica et Pharmacologica Neerlandica, 1962, 11, 485-493.

The influence of an emotionally neutral image upon the averaged occipito-cortical response evoked by periodic lightflashes was studied in 15 subjects.

In 13 of these subjects systematic changes due to the presentation of a retinal image were found.

Amplitude reduction was the most characteristic alteration: often confined to that part of the response occurring more than some 150 msec after the beginning of the flash.

It is argued that there is no reason to invoke the participation of an "attention mechanism".

In the same experiments the influence of flash counting was studied. One of the 15 subjects showed systematic changes due to flash counting, consisting of an increase of the first negative wave (80 msec after the start of flash), whereas image formation in the same subject gave amplitude reduction of later components. This reaction to flash counting was the only instance where it was necessary to postulate an "attention mechanism".

- 549 Hoffmann, H., Mayer, H., Grundei, M., & Meier, W. Verkehrsmedizinische untersuchungen zur frage des kreislaufverhaltens, der korperlichen und seelischen belastung von kraftfahrzeugfuhrern in verschiedenen fahrzeugtypen und auf fernfahrten. [Medical research on circulation and physical and mental stress in long-distance drivers of various types of vehicles.] Zentralblatt fur Verkehrs-Medizin Verkehrs-Psychologie Luftund Raumfahrt-Medizin, 1971, 17, 193-224.

A report on research to determine variations in cardiovascular function (ECG, pulse and blood pressure) and respiratory frequency during an 8-h journey, by night or by day. Fifty-six professional or non-professional drivers were tested. Preliminary remarks on physiology and legal matters are followed by a detailed description of methods. Results are recapitulated in numerous tables and diagrams, accompanied by commentaries. Pulse and respiration rates increased proportionally to driving errors and ECG modifications. There was virtually no difference found between night and day journeys.

- 550 Hoffmann, H., Reigers, H., Strubel, H., Quednow, H., & Schneider, H. Kreislaufuntersuchungen bei kraftfahrzeugfuhrern unter variierten fahrbedingungen. [Studies of blood circulation of motor vehicle drivers under various driving conditions.] Zentralblatt fur Verkehrs-Medizin Verkehrs - Psychologie Luftund Raumfahrt - Medizin, 1970, 16, 192-233.

Report on studies carried out to provide an insight into the demands imposed on motor-vehicle drivers by various traffic conditions and to determine to what extent disease reduces aptitude for driving or, conversely, to what extent illness may be aggravated by driving. After describing the investigational methods adopted, the authors discuss the behaviour of the circulation of healthy drivers and of drivers with vegetative nervous disorders or with organic cardiovascular disorders (coronary insufficiency, cardiac muscular insufficiency, high blood pressure) in simple and critical traffic situations, in the light of their findings and the literature. Finally, they consider the effects of driving practice on the psychic and physical stress to which drivers are subjected. Their findings are analyzed by statistical methods.

- 551 Holloway, F. A., & Parsons, O. A. Physiological concomitants of reaction time performance in normal and brain-damaged subjects. Psychophysiology, 1972, 9, 189-198.

Autonomic and somatic concomitants of simple reaction time performance were examined in normal and brain-damaged patients. The reaction time task involved a warning stimulus preceding the execution stimulus by a variable foreperiod. The normal Ss displayed the expected relationships between performance and physiological activity, such that fast reaction times were associated with greater HR deceleration, larger electrodermal response magnitudes, and less EMG activity during the preparatory foreperiod of the task. BD Ss, however, generally displayed either no relationships between autonomic or somatic activity and reaction time or a relationship opposite to that seen in normals, namely, that slower reaction times were associated with larger autonomic responses to the warning stimulus. The results were discussed in terms of two possible mechanisms which may be operative in the BD Ss: (1) that their autonomic responsivity becomes "dissociated" from changes in the external environment, and (2) that such "dissociated" activity may represent or reflect an active source of interference with the S's ability to attend to or to efficiently execute the task.

552 Holoch, J. Wachsamkeitsprognose mittels Computeranalyse des Spontanen Elektroenzephalogrammes. [Vigilance prognosis through computer analysis of the spontaneous electroencephalogram.] Doctoral dissertation, Technische Universität München, 1972.

In the present study, an objective technique is presented for determining S's vigilance state by analysis of the spontaneous EEG, which holds out the prospect of an eventual on-line monitoring of the time course of human vigilance during prolonged observing activities.

After a review of methods for revealing consciousness states and of various vigilance theories, four hypothetical vigilance levels are distinguished which are clearly defined in the experiments by the task at hand and the behavior of S:

Nonspecific vigilance	(B) - eyes open, no task
Specific vigilance	(R) - eyes open, in anticipation of a signal to which S will respond
Diminished vigilance	(N) - eyes open, in anticipation of a signal to which S will not respond
False-alarm vigilance	(F) - eyes open, response with no objective signal

The experiment was based on Mackworth's Clock Test (1950), the premise being that the typical behavior of S during the experiment — namely response (R), non-response (N) or false response (F) — corresponds to different levels of vigilance which must be demonstrable in the EEG immediately prior to these states. Hence, only EEG segments 2.3 seconds in duration are selected for evaluation which directly precede a signal (R,N) or a response with no signal (F). The treatment of EEG data in terms of acquisition, storage and mathematical analysis is based on a system for the identification of EEG spectral patterns whose theoretical precepts and practical realization are described by Boettge (1972).

In the present study, four Ss were each subjected (after a preliminary practice test) to eight tests within a 14-day period (first test series) and two repetitive tests six months later (testing phase).

Although the vigilance levels defined in this paper describe only a very limited region of the vigilance continuum, we were surprisingly successful in differentiating these levels: on individual evaluation of data from the first test series, an average of 79% of all random samples are correlated with the correct vigilance group when 4 parameters are used, and 100% with 10 (at most) 20 parameters; when the data are treated collectively for all four Ss, the figures are 51% with 4 parameters and 79% with 30 parameters.

The differentiation of data from the testing phase, which was done with the aid of the 10-dimensional discriminant functions found in the first test series, is satisfactory for only two Ss: 69 and 58%, respectively, of all random samples are assigned to the correct group. It is presumed that the unsatisfactory results of the testing phase for the other two Ss (34 and 29% correct classifications) are attributable to various variance components not included in the data obtained during the first 14-day test series.

- 883 Honda, H. Visually evoked potentials during pattern discrimination tasks: II. Further evidence. Tohoku Psychologica Folia, 1974, 33, 119-133.

In order to evaluate the reliability of the results obtained in a previous study, the changes in wave form of the visually evoked potentials (VEPs) were observed in human Ss during pattern discrimination tasks. Two tasks were given to 10 Ss. Each task forced Ss to focus their attention on one of the discriminative cues (size or form) of the geometrically patterned stimuli. When Ss were asked to count in silence the stimuli, dividing them into large stimuli and small stimuli regardless of their forms, the VEP wave form was altered by the size rather than the form of the stimuli. On the other hand, when Ss were asked to count in silence the stimuli, dividing them into square stimuli and diamond stimuli regardless of their size, the VEP wave form was altered by the form rather than the size of the stimuli. Results show the orderly effects of selective attention on VEP wave form, and were interpreted to reflect the electrical brain activities closely related to pattern perceptual processing.

- 884 Hope, R. E. Pupillary size change as correlated with mental activity. Unpublished master's thesis, Naval Postgraduate School, Monterey, Calif., 1971. (DDC No. AD-720 697)

An indirect measurement of mental activity was correlated with changes in pupil size during simple multiplication solving. There was also a close correlation between mental activity and the difficulty of the problem. With an increase in difficulty, there was an associated increase in pupil size for correctly answered problems, but an associated decrease in pupil size for wrong replies.

- 885 Hopkin, V. D. Conflicting criteria in evaluating air traffic control systems. Ergonomics, 1971, 14, 557-564.

Sources of conflicting criteria in evaluating air traffic control systems include the multiple aims of air traffic control, the numerous performance measures for each task, incompatibility among behavioral, physiological and subjective data, the needs of man in contrast with those of the system, and individual differences. The extent of the conflicts may have been underestimated in the past, because certain relevant measures have been neglected. The solution requires greater awareness and quantification of these further measures and of the sources of conflict in evaluation criteria, plus practical acknowledgement of them in the initial specification of air traffic control systems.

- 556 Hord, D., & Hilbert, R. Effect of sensory mode on the coherence and phase of brain activity. Psychophysiology, 1977, 14, 94. (Abstract)

An important development for psychophysiological research is the spectral analysis of brain activity during short time epochs, of the order of seconds. In the present work they are examined as electrophysiological correlates of focused attention during auditory and visual decision making tasks.

In 20 human subjects, frontal, central and occipital EEG was recorded before and after each of 40 decisions per subject. The decisions occurred when gradually changing stimulus parameters became sufficient for the subject to make a discrimination. Focused attention is assumed to occur in the time epoch during which the decision is made. Two-sec EEG epochs preceding and following each decision were spectral analyzed, using a Fast Fourier Transform. Cross spectra were obtained for intra and interhemispheric pairs. Response averaging across trials was then applied to the distributions of spectra to yield averaged spectra (AS) within subjects for the short time epochs preceding and following decisions in the visual and auditory modes.

The resulting mean spectra had a low noise component for the same reason that averaged evoked potentials do. The derived measures of coherence and phase, based on averaged cross spectra, were then compared across sensory mode. The hypothesis that the AS, coherence, and phase angle of EEG during short time epochs differentiates sensory mode was partially supported. The results imply that the phase angle of EEG, when based on short time epochs, may be a useful parameter of brain function.

- 557 Hord, D. J., Lubin, A., Tracy, M. L., Jensma, B. W., & Johnson, L. C. Feedback for high EEG alpha does not maintain performance or mood during sleep loss. Psychophysiology, 1976, 13, 58-61.

Can performance and mood during sleep loss be maintained by self-induced high EEG alpha activity? In a previous study, most of the performance and mood measures showed sleep-loss impairment regardless of EEG alpha level, but attention and reported sleepiness were less impaired for the high-alpha group (although the differences were of doubtful significance). A constructive replication was carried out. In Group A (N=10) auditory feedback was contingent on high alpha, and in Group B (N=10) auditory feedback was contingent on low alpha and low theta. All subjects were repeatedly measured on auditory vigilance, addition, immediate recall, and feelings of sleepiness for 40 hrs during which no sleep was permitted. Sixty min of EEG feedback were given during each block of 220 min. Group A did produce significantly more alpha for the first 24 hrs but this difference was not maintained. Both groups had significant sleep-loss impairment on all measures. There were no significant differences between the groups in the amount of impairment. Self-enhanced EEG alpha activity does not prevent impairment of performance or mood during sleep loss.

- 588 Hord, D. J., Tracy, M. L., Lubin, A., & Johnson, L. C. Effect of self-enhanced EEG alpha on performance and mood after two nights of sleep loss. Psychophysiology, 1975, 12, 585-590.

Can the deleterious effects of acute sleep loss on performance and mood be ameliorated by self-enhanced alpha activity? Fourteen Naval volunteers were divided equally into an experimental (alpha-contingent auditory feedback) group and a yoked control (pseudofeedback) group. All subjects received feedback plus performance and mood tests during 3 baseline days and following 2 days and 2 nights without sleep. Feedback was given for 45 min in the morning and 45 min in the afternoon, preceding performance and mood tests. The self-enhanced alpha (experimental) subjects did produce more alpha than the yoked controls during all feedback sessions except for one pair that was discarded. Of eleven measures that were sensitive to sleep loss, two performance scores and one mood score showed significantly less sleep-loss decrement for the self-enhanced alpha group (at the usual univariate .05 level). Two recall scores and an anxiety score showed more impairment for the self-enhanced alpha group following sleep loss. The differences were not significant, however, by the conservative Dunn-Bonferroni multivariate criterion, so our results are not conclusive.

Alpha enhancement may help maintain performance that requires continuous attention, such as counting and auditory discrimination, but does not ameliorate the sleep-loss effect for anxiety, memory, and addition.

- 589 Horn, G. Physiological and psychological aspects of selective perception. In D. S. Lehrman, R. A. Hinde, and E. Shaw (Eds.), Advances in the study of behavior. (Vol. 1). New York: Academic Press, 1965.

These remarks on the physiological events that accompany selective perception may be summarized in the following way. When an organism attends to a stimulus, adjustments are made in the sense organs so that the stimulus evokes a brisk response in the sensory pathways. The response is sharpened and intensified by certain neural mechanisms which have been described. The input appears to have access to cells in the tectotegmental region, and perhaps to other cells whose response properties are similar to these. It is possible that throughout the period of perceptual response this access is maintained, when access to these cells is no longer available to the input the perceptual response to that input may cease.

The neural response evoked by a stimulus applied to an unattended sense organ tends to be weak because the sense organ is not adjusted to bring the "image" of the stimulus sharply to bear on the array of receptors, and because activity in the attended pathways injects "noise" into the unattended pathways. In many, perhaps most, instances, interference in both these ways is almost certainly inadequate to prevent signals evoked by the unattended stimulus from reaching the cerebral cortex. In the course of passing to and reaching the cerebral cortex, the stimulus is analyzed. Presumably it is compared in some way with pre-existing neural traces of past experience. On the basis of this comparison it may be supposed, the input is either not permitted access to cells of the tectotegmental type, in which case the input fails to evoke a perceptual response, or access is permitted. In the latter case, access by the previously attended stimulus is cut off. This input ceases to elicit a perceptual response, which is now achieved by the previously unattended stimulus.

- 000 Horstfehr, H. O. The spatial sum of evoked responses to a single stimulus (light or sound) recorded from the human scalp. Electroencephalography and Clinical Neurophysiology, 1967, Supplement 26, 39-146.

The slow potential changes or Σ waves (evocation) elicited by light stimuli (invocation) which fall in the positive rather than negative deflections of spontaneous activity, seem to have similiarity with the Expectancy Wave of Walter et al. (1964).

Whereas the cause of the E wave (expectancy, decision, intention) is energy derived from the human being himself, the Σ wave is the reaction to energy (action) which comes from outside the human system.

In both cases the energy influence (intention, light) causes in the organ, the human brain, the appearance of a voltaic pile or potential difference: the potential energy precedes the actual energy. In other words, the intention to move one's arm (voltaic pile) precedes the intended movement (spikes).

If bioelectrogenesis is intended in these terms, we must find out how human beings may generate voltaic piles in their organs by will.

- 001 Huchingson, R. D. The effects of time stress and task difficulty on closed-loop tracking performance and physiological correlates (Doctoral dissertation, Texas Christian University, 1970). Dissertation Abstracts International, 1970, 31, 6292B. (University Microfilms No. 71-8943)

An exploratory study was conducted to determine changes in human performance and physiological correlates in a time-limited situation involving pursuit tracking. The tracking task involved a cathode ray oscilloscope in closed-loop with a control stick.

Twenty male college students performed nine pursuit tracking tasks which were combinations of three levels of time constraint and three levels of task difficulty. Levels of time constraint represented 100%, 60%, and 40% of the subject's own task time requirement at the end of training while working at the same task without a time limit. Levels of difficulty were introduced by three "time constants" representing minimum durations of target superimposition required for lock-on. The physiological correlates which were recorded were autonomic changes in heart rate, respiration rate, and skin resistance levels.

The principal findings were that several aspects of performance improved with increasing time constraint. Increasing task difficulty was associated with increased variability in the time between sub-task completions, reduced efficiency in acquiring targets, but also less integrated absolute error. Autonomic changes were found to be related to the treatment conditions. The heart rate data suggested a reduction in effort on those tasks which were failed badly and an increase in effort on tasks where the outcome was in doubt until the end. The experimental technique of basing experimental time limits upon the subject's time requirements during training was found to be successful in preventing differences in subjects's skill from confounding difference due to the treatment conditions.

- 882 Huchingson, R. D. Effects of time constraint on closed-loop tracking performance and change in heart rate. Perceptual & Motor Skills, 1973, 36, 1195-1198.

Investigated the effects of 2 levels of time constraint upon task completion performance and mean heart-rate changes during testing. Ss were 20 male university students. The pursuit-tracking task involved a cathode ray oscilloscope in closed loop with a control stick. The success criterion was 10 target lock-ons within predetermined time limits (100, 60, and 40% of each S's self paced time requirements at the end of training). Results indicate that task-completion performance did not degrade with time constraint at the levels investigated. Mean change in heart rate was significantly greater on those tasks where success was in doubt until the end than on tasks where success or failure was a likely conclusion.

- 883 Hung, G., & Marg, E. Computer-assisted eye examination: III. Physiological indices for subjective refraction. American Journal of Optometry & Archives of American Academy of Optometry, 1973, 50, 968-977.

Made EKG, blink, GSR, arm acceleration, and respiration measurements on 38 patients during clinical, computerized eye examinations to determine whether there was any correlation between these measures and S's uncertainty about his response as indicated by reaction time and tone of voice. It was found that the EKG (4 Ss) and respiratory rate (4 Ss) were usually steady and insensitive to uncertainty of response. For 3 out of 10 Ss tested in the blink response, a rough correlation was found. The other 7 Ss produced noncorrelating responses. For 12 Ss tested, GSR was an unreliable indicator of uncertainty. Eight Ss showed little or no arm acceleration movements during the attentive portions of the eye examinations.

- 884 Hutton, D. W. Eye movements and physiological responses to visual stimuli. Viewpoints, 1973, 49, 29-36.

Reviews studies of eye movement and other physiological responses to visual stimuli with relevance to the design of instructional materials. It is suggested that physiological monitoring of vision may provide not only a better understanding of visual perception and information processing, but also offer some general guidelines for design of materials by the educational practitioner.

- 885 Hyndman, B. W., & Gregory, J. R. Spectral analysis of sinus arrhythmia during mental loading. Ergonomics, 1975, 18, 255-270.

A technique is presented for digitally processing cardiac intervals to produce the low-pass filtered cardiac event sequence (LPFCES), a regularly sampled (in time) band-limited signal, representing in a standard form the information contained in the cardiac intervals. The technique takes into account the physiological mechanisms of information transfer across the pacemaker, and thereby produces a signal that has a physiological counterpart: autonomic activity converging on the sino-atrial node. Sinus arrhythmia (SA) is then defined quantitatively as those harmonic components of the cardiac event sequence which correspond to the signal that modulates that event sequence (i.e., the converging autonomic activity). SA is scored by calculating the average total power (ATP) of the LPFCES, as well as the contribution of changes in average band power (ABP) of various spectral bands to the ATP changes. This scoring technique is shown to give a reliable indication of mental loading (and possibly reserve capacity) in decision-making tasks. Possible mechanisms of reduced SA with mental loading are explored.

I

- 886 Innes, H. E. Subjective and physiological indicators of fatigue in a vigilance task. Unpublished master's thesis, Naval Post-graduate School, Monterey, Calif., 1973. (NTIS No. AD-761 503)

This research represents an investigation to determine intra-correlations among physiological parameters, a subjective rating of fatigue and performance during a vigilance task. Simple and multivariate analyses indicate positive relationships between subjective ratings of fatigue and heart rate, neck muscle tension level and two measures of sinus arrhythmia. Subjective ratings were found to correlate with time-on-task. Effects of motivation on sinus arrhythmia are discussed in the context of information processing. Single variate correlations between performance and heart rate, as well as with subjective ratings of fatigue, were observed with significant but low correlation coefficients. Multivariate correlation of neck muscle tension level and sinus arrhythmia were found to be significantly correlated with performance.

- 887 Irwin, D. A., Knott, J. R., McAdam, D. W., & Rebert, C. S. Motivational determinants of the "contingent negative variation." Electroencephalography and Clinical Neurophysiology, 1966, 21, 538-543.

1. The motivational correlates of the vertex negative slow potential shift seen during reaction time foreperiod, called "the contingent negative variation" or "expectancy wave", have been studied in two experiments with young adult human males.

2. In the first experiment, a manual response to a visual stimulus was determined by the position of the preceding auditory signal. Measurable CNVs following the auditory signal were seen in all conditions, but they were significantly larger when a manual response was made to the second, visual, stimulus. No significant relationships were seen between CNV magnitude and either reaction time or anticipatory EMG activity.

3. In the second experiment, left and right tones were followed by weak and by painful finger shock, respectively. Key-press to both shocks was instructed on one half of the trials with order counterbalanced. CNVs were larger when the warning signal indicated painful rather than weak shock would occur, and CNVs were also larger during response than non-response conditions. No interaction was seen. Although reaction times were significantly shorter to the strong shock, a significant correlation between CNV magnitude and reaction time could be demonstrated only within the weak shock condition.

4. These results were interpreted as indicating that if the contingent negative variation is a measure of "expectancy" then the definition of such a term must explicitly include motivational factors.

- 800 Irwin, D. A., Rebert, C. S., McAdam, D. W., & Knott, J. R. Slow potential changes (CNV) in the human EEG as a function of motivational variables. Electroencephalography and Clinical Neurophysiology, 1966, 21, 412-413. (Abstract)

The "contingent negative variation" (CNV) described by Grey Walter, is a vertex negative slow potential shift seen during reaction time foreperiod, which has been related to "expectancy". This report, based on 46 normal human subjects, seeks further psychological correlates of the CNV.

In Experiment I (N=8), manual response to light was determined by the position of a warning tone (left tone, no response; right tone, response). Measurable CNVs, seen in response to tone in all conditions, were significantly larger when a manual response was to be made to light. In Experiment II (N=14), left and right tones were followed by weak and by painful finger shock. On half the trials, order counterbalanced, key-press to both shocks was instructed. CNVs were larger preceding strong, painful than weak shock, and for response than non-response trials. No interaction was seen. In Experiment III (N=12), left and right lights preceded threshold and suprathreshold tones to which response was instructed on half the trials. CNVs were larger during response conditions, and also following the signal preceding the threshold tone. No interaction effects were seen. In Experiment IV (N=12), light was followed by tone to which response requiring variable effort was instructed. CNVs were significantly larger when high than when low effort was required.

These data suggest that "expectancy" per se, is not the unique psychological correlate of the CNV; conditions which increase the energizing factors in behavior ("motivation", "drive", "activation", etc.) also increase the magnitude of the CNV.

- 800 Itil, T. M. Digital computer analysis of the electroencephalogram during rapid eye movement sleep state in man. Journal of Nervous and Mental Disease, 1970, 150, 201-208.

To answer the question of whether the scalp-recorded electroencephalographical (EEG) pattern of the rapid eye movement (REM) sleep (paradoxical sleep) can be discriminated from the drowsiness state and awakening state, the visually identified, artifact-free, digital computer-analyzed EEG samples of these three stages in seven volunteers were compared for each person as well as for the entire group. Statistical evaluation (analysis of variance and discriminant function) of the quantitative EEG measures demonstrated that the REM period is characterized by a low voltage EEG with less alpha activity and more slow and very fast activity than the awakening and the drowsiness states. Since these kinds of EEG alterations have been observed, particularly after anticholinergic "hallucinogenic" drugs, and since the increase of fast activity during anticholinergic drug-induced "delirium" is related to an increase of perceptual disturbances, a relationship between increased fast waves and an increase of mental activity during sleep (dream) has been postulated.

- 570 Ivannikov, V. A. Orientirovochnaya reaktsiya kak reaktsiya prednastroiki pri neopredelennosti situatsii. [The orienting reaction as prereadying reaction when the situation is uncertain.] Psikhologicheskie Issledovaniya, 1969, 1, 149-158.

Twenty 18-26 yr old Ss participated in a study of speed of extinction of the different components of the orienting reaction as a function of degree of situational uncertainty and character of the organism's actions. EEGs recorded the electrical activity of the occipital, parietal-occipital and motor areas of the cortex of both hemispheres; EMGs recorded that of the ulnar extensors of both hands or the deep flexors of the fingers. GSRs were recorded from the foot. In 2 series of experiments, 2 photic signals ($p_1 = 1, p_2 = 0$; $p_1 = .5, p_2 = .5$) were presented 8-15 sec apart, each eliciting a motor reaction in the appropriate hand. The data lead to the view that the orienting reaction is not merely a simple reflex, but a complex adaptive reaction under special conditions where uncertainty of prognosis exists.

J

- 571** Janisse, M. P., & Kuc, S. G. The cognitive-emotional arousal distinction as assessed by pupil size and heart rate. Psychophysiology, 1977, **14**, 80. (Abstract)

Several studies have shown pupil size and heart rate to be negligibly or negatively correlated. In the present study a difficult 7-number digit span (DS) was employed to assess pupil and heart indices during both correct and incorrect trials. Subjects were grouped on the basis of: 1) Stress (ego- or nonego-threatening) instructions, and 2) Intelligence (ability on the DS Forward subscale of the WAIS). Results were as follows: 1) During instructions there was no difference between the Stress groups in pupil size, but heart rate interacted with time such that following the threatening part of the instructions, the High Stress group exhibited greater heart rate. 2) During the Input phase pupil size increased over time and was larger in the High Intelligence group and for Correct trials, but no main effect was found for Stress. Heart rate during Input was significantly higher for the High Stress group, but no effects were found due to Intelligence or Correctness, nor was there any increase over time. 3) During Output, pupil size and heart rate maintained the same relationships as during Input. The discussion pointed to the differences between the present study and that of Kahneman et al. (1968): that is, presence of stress instructions, a more difficult task, and a specific measure of intelligence. It was concluded that the pupillary response was more sensitive than heart rate to cognitive variables, having distinguished Intelligence groups, Correctness of trials, and increased load during Input. Conversely, heart rate was more sensitive to emotional variables, having distinguished the Stress groups both during Instructions and during Input. Finally, from the pupillary data on Intelligence and Correctness it was concluded that performance was better here due to greater effort, and that poor performance was due to lack of effort rather than greater task difficulty.

- 572** Jankovich, J. P. Human factors survey of locomotive cabs (FRA-OPP-73-1), Crane, Indiana: Naval Ammunition Depot, June, 1972. (NTIS No. PB 213 225)

Purpose of the investigation was to review design of locomotive cabs from the human factors point of view. The following areas of human factors engineering are discussed: construction of cab interiors; design of controls and displays; atmospheric conditions in the cab; noise and vibration; seat design; physiology and vigilance of train driving.

Discussion of each subject is divided into three sections: (1) survey of relevant literature, (2) conditions on domestic locomotives, and (3) recommendations to improve present models and future design. The recommendations relate only to the designs reviewed under the scope of this study and represent the viewpoint of the author and not necessarily those of the FRA.

- 573** Jarvilehto, T., & Fruhstorfer, H. Differentiation between slow cortical potentials associated with motor and mental acts in man. Experimental Brain Research, 1970, 11, 309-317.

In six human subjects negative slow potentials associated with voluntary movements and discrimination tasks were studied. On the basis of their spatial distribution on the scalp the slow potentials could be divided into three groups:

1. A central-dominant potential ('readiness potential') which is suggested to be a sign of general readiness to perform a task.
2. A frontal-dominant potential which seems to be related to the uncertainty of the subject.
3. A centro-frontal potential ('contingent negative variation') which probably results from a summation of the electric fields of the central-dominant and the frontal-dominant potential.

- 574** Jarvilehto, T., & Fruhstorfer, H. Is the sound-evoked DC potential a contingent negative variation? Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 105-108.

Slow potentials, elicited in man by short sounds or by pauses interrupting a continuous sound, were examined to ascertain whether the sound-evoked slow potential is an objective correlate of the sound.

Both sound- and pause-evoked negative slow potentials occurred; they did not differ in their characteristics and had the same fronto-central distribution as the CNV.

On the basis of these findings it seems to be most probable that the sound-evoked slow potential recorded at vertex is a contingent negative variation.

- 575** Jarvilehto, T., & Mantysalo, S. Dependence of the CNV on the probability of occurrence of S_2 . In W. C. McCallum & J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

The present results confirm the findings of Karrer et al. (1973a) who found reduction in the CNV amplitude with an S_2 probability of 1.00 compared with a probability of 0.5. The present results further indicate that the changes in the probability of occurrence of S_2 do not produce correlated changes in the CNV and the RT. The change in the topography of the CNV as a function of the probability of occurrence of S_2 supports the notion of at least two different components of the CNV.

- 576** Jenness, D. Auditory evoked-response differentiation with discrimination learning in humans. Journal of Comparative & Physiological Psychology, 1972, 80, 75-90.

The possible functional significance of the registration of the salience of stimulus events in the vertex potential was investigated with a discrimination-learning paradigm involving stimuli that were equally informational but of different value. Wave forms were obtained over the entire course of acquisition. Level of discriminative accuracy and extent of evoked-response differentiation were closely related, and differentiation had to predominantly reflect improvement in the perceptual-cognitive "labeling" of the stimuli. When the identical stimuli served a feedback rather than a cueing role, evoked responses were markedly different, and there was no apparent relation to accuracy or learning.

- 577** Jennings, J. R. Psychophysiological correlates of information processing in the obese and underweight. Paper presented at the Thirteenth Annual meeting of The Society for Psychophysiological Research, Galveston, Texas, 1973.

In conclusion I feel these results support three main points: 1) Active memorization has a very potent effect on cardiac IBI - countering deceleratory influences and producing cardiac acceleration. 2) The obese performance on information processing tasks is influenced by difficulty and, perhaps, only to the degree to which the difficulty requires them to ignore external stimuli. 3) The obese show a greater tendency than the underweight to exhibit cardiac deceleration, and less tendency to exhibit cardiac acceleration. These effects may reflect particular information processing sets within the obese.

- 578** Jennings, J. R., Averill, J. R., Opton, E. M., & Lazarus, R. S. Some parameters of heart rate change: Perceptual versus motor task requirements, noxiousness, and uncertainty. Psychophysiology, 1970, 7, 194-212.

Investigated sensorimotor integration and physiological patterns in a modified RT task with 30 male 18-28 yr old students. Following a ready signal, 1 of 2 discriminative signals indicated that a right or left reaction was to be made to a go signal. For 1 group, the discriminative and go signals occurred simultaneously; for another group, the go signal was delayed 10 sec. In different sessions, shock occurred with the discriminative signal on 0, 33, or 100% of the trials. The basic pattern of heart rate response was the same in all conditions, i.e., acceleration followed by deceleration immediately prior to the discriminative and go signals. All experimental manipulations appeared to contribute to cardiac deceleration; e.g., the greatest decrease occurred prior to the simultaneous discriminative-go signal with 33% shock probability. The least deceleration (and fastest RTs) occurred to the delayed go signal. Anticipation of a motor response and/or shock also accentuated the accelerative limb of the heart rate curve, as well as producing increased skin conductance. Muscle action potentials from the chin showed an equivocal relationship to cardiac acceleration (and deceleration) and to faster RTs. Results are discussed in terms of an attentional hypothesis, and their relevance to speculations by J. I. Lacey and P. A. Obrist is examined.

- 579 Jennings, J. R., & Wood, C. C. Principal component separation of pre- and post-response effects on cardiac interbeat-intervals in a reaction time (RT) task. Psychophysiology, 1977, 14, 89-90. (Abstract)

Statistical dependencies in physiological data pose interpretive problems for most psychophysiological research. Cardiac interbeat-intervals (IBIs) exhibit such statistical dependencies as well as sensitivity to a variety of physiological and psychological variables. Consequently, the average cardiac response in tasks such as reaction time may reflect a complex mixture in which the effect of both psychological events and cardiac control mechanisms may be represented in each IBI. In this report satisfactory separation of independent components underlying the average IBI response to a choice RT task is demonstrated. Principal component analyses of variance-covariance matrices were performed on sets of 1280 RT trials from each of 8 subjects. Components were then labelled allowing comparisons and averaging across subjects. The first four components were clear-cut, consistent, and accounted for over 83% of the variance in all subjects. These were: a) a pre-response or anticipatory deceleration component; b) a post-response or motor effort component; c) an initial values component, and d) an RT component loading almost exclusively on the RT itself. The interpretation of the derived components was verified by showing their differential sensitivity to two independent variables in the experiment, cardiac cycle time and RT speed. These variables showed similar effects in analyses of variance of the original data. The validity and clarity of the separation of pre- and post-response effects suggested that differences in accelerative recovery could be attributed to response-induced changes rather than homeostatic rebound from anticipatory deceleration.

- 580 Jerison, H. J. Activation and long term performance. Acta Psychologica, 1967, 27, 373-389.

Is activation theory useful or necessary for the analysis of long term performance on perceptual tasks? After criticizing the theory for being too broad and nonspecific, because even contradictory results would not embarrass it, this report illustrates the problem with data on human and animal vigilance. It is concluded that activation theory in several forms may be necessary to understand different phases of vigilance performance. The questions relevant for activation theory include the probable inhibition of observing behavior when an overload is established by eliciting observing at a high rate, the temporal conditioning of levels of arousal, and motor aspects of the emission of detection-indicating responses.

- 581 Jerison, H. J. Vigilance: A paradigm and some physiological speculations. Acta Psychologica, 1970, 33, 367-380.

The paradigm followed in experiments on human vigilance is discussed in detail to show relationships between vigilance, signal-detection, and animal discrimination experiments. Parts of the paradigm involve 'observing response' and 'decision whether stimulus is signal' as hypothetical constructs, and suggestions from the literature on electroencephalography are developed to convert these to empirical constructs. Specifically, an early potential (100-200 msec latency) of the averaged evoked response may correspond to the observing response, and a late potential (350-600 msec latency) may be related to the way the observer decides whether or not a stimulus is a signal.

- 582** Joachimsthaler, J., & Chaloupkova, E. Zmeny tepove frekvence u pracovnic s nizkym energetickym vydejem. [The changes of the pulse rate in employees with a low energetic output.] Ceskoslovenska Hygiena, 1973, 18, 101-104.

The authors investigated the pulse rate of women working on adjusting relays of telephone exchange in Tesla plant during their work. From the point of view of the physical loading it is a light work. During the measuring the work was being done with unalternating intensity. Also physical conditions (light, noise, microclimate) in the telephone exchange did not change. During the work the pulse rate increased in average by 21%, compared to the normal level. Such an increase is caused by several influences, among which the most important is neuropsychical load with a significant emotive factor. The increase of the pulse rate after meals during work hours is caused by specific dynamic effect of food.

- 583** Johansson, G., & Frankenhaeuser, M. Temporal factors in sympatho-adrenomedullary activity following acute behavioral activation. Biological Psychology, 1973, 1, 63-73.

Gave 16 19-33 yr old male students a complex choice-reaction task under time pressure. Epinephrine and norepinephrine excretion, heart rate, and subjective reactions were measured before, during, and after the work period and at corresponding points in time in a control session without work. Mean epinephrine excretion, heart rate, and subjective arousal increased significantly during work and returned to baseline levels within 1-2 hrs after the end of work. There were large inter-individual differences in the rate at which epinephrine output decreased. When Ss whose epinephrine output decreased rapidly were compared with those whose output decreased slowly, it was found that rapid decreasers had higher baseline levels of epinephrine, performed better on the choice-reaction task, and had lower scores in neuroticism. The significance of temporal factors in epinephrine-mediated adjustment to environmental stressors is discussed.

- 584** John, E. R., Herrington, R. N., & Sutton, S. Effects of visual form on the evoked response. Science, 1967, 155, 1439-1442.

The average visual evoked potentials elicited from relaxed human subjects are different for a blank visual field and one containing a geometric form, are different for different geometric forms of equal area, are similar for versions of the same geometric form of unequal area, and are different for two printed words equated for total letter area. These findings suggest that the waveform of evoked responses is not determined solely by the set of peripheral receptors which is stimulated, but it also reflects the perceptual content of the stimulus.

585 Johnson, B. R. Physiological variables and performance on a counting task (Doctoral dissertation, University of Georgia, 1961). Dissertation Abstracts, 1962, 22, 2883-2884. (University Microfilms No. 61-6583)

This experiment was designed to investigate the effects of several physiological measures of arousal on the performance of a complex mental counting task.

Forty-five male University of Georgia students volunteered for the project.

The physiological measures included respiration frequency in inspiration-expiration cycles, initial level of galvanic skin conductance, frequency of 500 ohm GSRs, and frequency of 1000 ohm GSRs. The physiological measures were taken at the same time the counting task was being performed.

The performance task involved a panel of three lights which were used to pace three simultaneous mental counts. The subjects were required to respond by pressing one of three buttons each time the count for a given light reached a certain value.

The empirical findings were as follows:

Significant intercorrelations were found between initial conductance level on count patterns of 4, 7, and 10. Significant negative correlations were shown between initial conductance level and frequency of GSRs. Correlations between the galvanic measures and respiration were very low.

No significant differences existed between the three performance variables, all having correlations of .53 and higher.

The important result was that the inverted U-shaped function between arousal and performance was not substantiated with this particular performance task and with these measures of arousal. The conclusion was that the inverted U-shaped function may be dependent upon the specific task or situation involved rather than being applicable to behavior in general. The results were discussed in light of Jerison's original work with this counting task and implications for further research were indicated.

586 Johnson, H. J. Decision making, conflict, and physiological arousal. Journal of Abnormal and Social Psychology, 1963, 67, 114-124.

In order to evaluate the effects of difficult discrimination upon the physiological arousal of the organism, 4 groups of 15 female Ss were subjected to different degrees of discrimination difficulty in an avoidance learning situation. Those Ss who were subjected to relatively high degrees of difficult discrimination manifested higher levels of physiological arousal than did Ss who were not confronted with discrimination problems. The implications of this finding are discussed with regard to the etiology of experimental neurosis.

- 587 Johnson, H. J., & Campos, J. J. The effect of cognitive tasks and verbalization instructions on heart rate and skin conductance. Psychophysiology, 1967, 4, 143-150.

Investigates the effects of cognitive tasks and verbalization instructions on heart period (HP) and skin conductance (SC). Two tasks (imagining common scenes and solving mental arithmetic puzzles) were used to test the hypothesis that conditions requiring attention to internal processes (rejection of the environment) are accompanied by cardiac acceleration and SC increases. Each task was administered under 3 instruction conditions: no, later, and concurrent verbalization. The imagination task was associated with no significant changes in HP or SC unless S was talking or preparing to talk. Mental arithmetic resulted in cardiac acceleration and SC increase even when no verbalization was required; however, this is perhaps due to covert verbalization inherent in the process of solving mental arithmetic problems. Both later and concurrent verbalization produced significant increases in physiological activation during the arithmetic task. The notion that conditions requiring rejection of the environment are associated with specific physiological changes is not supported. The changes are generally attributable to the verbalization requirement. The effects of instructions requiring S to verbalize later are interpreted as due to either a motor set phenomenon or fear of being evaluated while talking.

- 588 Johnson, H. J., & May, J. R. Phasic heart rate changes in reaction time and time estimation. Psychophysiology, 1969, 6, 351-357.

Compared the phasic cardiac changes of 2 groups of 20 undergraduate males with one group performing an RT task and the other a time estimation task. The cardiac changes of the 2 groups were very similar with both showing deceleration shortly before they made their motor responses. The RT task group showed this to a greater extent than the time estimation group. It is concluded that the anticipated deceleration observed under RT conditions is not wholly attributable to the direction of attention.

- 589 Johnson, L. C. A psychophysiology for all states. Psychophysiology, 1970, 6, 501-516.

The question is asked, can the same visceral changes occur in different states of consciousness. A survey of EEG and autonomic activity found in the awake state and during the various stages of sleep leads to the conclusion that the question must be affirmatively answered. The conclusion is reached that EEG and autonomic activity cannot be used to define states of consciousness. The state of consciousness of the subject must first be known before the physiological significance and possible behavioral meaning of the EEG and autonomic responses can be inferred.

- 590 Johnson, L., Lubin, A., Naitoh, P., Nute, C., & Austin, M. Spectral analysis of the EEG of dominant and non-dominant alpha subjects during waking and sleeping. Electroencephalography and Clinical Neurophysiology, 1969, 26, 361-370.

The waking intensities of the delta, theta and alpha frequency bands have significant positive correlations with their respective intensities during sleep. Waking intensity of the alpha band never correlated with delta intensity during waking or sleeping.

These results favor the hypothesis of constant frequency generators for delta and sigma with an increase in energy during sleep; but they also fit the hypothesis of an alpha generator which decreases in frequency and energy during sleep.

The single, best discriminator of waking and the sleep stages was delta. Alpha and sigma intensities add to the discrimination. However, stage 1 and REM have very similar spectral profiles for all subjects. For the low alpha subjects, waking, stage 1, and stage REM have spectra that are almost indistinguishable.

- 591 Johnson, L., Naitoh, P., Nute, C., Lubin, A., Martin, B., & Viglione, S. EEG spectral and coherence analyses during awake and sleep. Electroencephalography and Clinical Neurophysiology, 1971, 31, 293-294. (Abstract)

Spectral profiles, 0.49 c/sec resolution interval, using three (1 min) periods of the six stages, were computed for the F₃, C₃ and O₁ leads. The frequencies studied were from 0.49 to 20c/sec. Pairwise coherence values were obtained from cross-spectral analyses, for F₃ with C₃, F₃ with O₁, and for C₃ paired with O₁.

F₃-C₃ coherence values, average 0.60, were highest of the three pairs. There were significantly higher coherences in the 8-10 c/sec activity during waking and REM in the F₃-C₃ pair; otherwise, it showed no clear differences among frequencies or stages. The F₃-O₁ pair had the lowest average coherence, 0.12. The C₃-O₁ pair gave an intermediate average coherence, 0.36, but provided the clearest differentiation among stages. Coherence values for all frequencies were lower during REM than all other stages. All subjects had higher sigma (12.5-14.5 c/sec) coherences during stages 2, 3, 4 than during W, 1, or REM. Multiple coherences (analogous to multiple correlations) were higher than pairwise coherences in all cases.

These data suggest a single source for sigma unique to stages 2, 3, and 4. Delta activity did not become more coherent during sleep, and multiple generators are indicated. A single linear generator source for alpha does not seem probable. Based on these data, two separate patterns emerged: that for stages 2, 3 and 4, and that for W, REM and 1.

- 592 Johnson, R. E., Jr., & Donchin, E. Equivocation, feedback, and the amplitude of P300. Psychophysiology, 1977, 14, 94-95. (Abstract)

Stimuli which deliver information tend to elicit an event-related potential (ERP) with a large P300 component. The amplitude of P300 depends on the task relevance of the stimulus and on the degree to which it is unexpected. Adams and Benson (1973) reported that the P300 elicited by a 30 dB tone which indicated to the subject success in task performance (S^+) varied as a function of the intensity of the corresponding failure indicator (S^-). As the intensity of S^- increased (from 0 dB to 30 dB), the amplitude of P300 decreased. These data support Ruchkin's (1975) suggestion that stimulus equivocation affects P300. However, it needs to be shown that: a) the results are independent of the absolute intensity of S^- but dependent on the difference in intensity between S^+ and S^- , and b) the amplitudes of the S^- and S^+ P300s behave similarly.

Subjects (three groups of 7) pressed a button one sec after a cue light, 200 msec later, a 50 msec, 1000Hz tone was presented at one of two intensities. Time estimates falling within a preset "window" around 1000 msec were followed by the S^+ ; over- and under-estimates were followed by the S^- . For subjects in groups 1 and 3 the S^+ was always a 30 dB SL tone; for group 2 the 30 dB SL tone served as the S^- . For groups 1 (S^-) and 2 (S^+) the tones were 0, 10, 20, 30, 40, and 50 dB SL. For group 3 the S^- tones were 10, 15, 20, 25, 35, 40, and 45, dB SL tones. The response windows were preset to insure the appearance of S^+ on approximately 50% of the trials.

EOG and EEG at P_z , C_z , and F_z were sampled at a rate of 100 samples/sec over a 1280 msec epoch beginning 480 msec prior to the tone.

P300 magnitude varied as a function of the intensity difference between S^+ and S^- : the smaller the difference, the smaller the amplitude of P300. This was true for P300 elicited by either S^+ or by S^- . We interpret these data in terms of the "discriminability" of the S^+ / S^- pairs, assessed in a choice RT experiment and in terms of the feedback value of the tones.

- 593 Jones, D. M., Gale, A., & Smallbone, A. Short term recall of 9-digit strings and the EEG II: Correlates of performance in trained subjects (visual presentation). British Journal of Psychology (awaiting decision).

The EEG of twenty-six subjects was measured before, during and after presentation of 24 trials of visually presented 9-digit strings for immediate recall. Subjects were given an efficient rehearsal strategy and six practice trials. Recall was superior than for an earlier study employing auditory presentation and unpracticed subjects. There was no relation between resting EEG and performance but increased abundance from the pre- to post-test correlated positively with recall errors. Digit presentation induced systematic alpha reduction. Within-subject analyses showed the EEG to be greater in abundance during low error trials; however a between-subject analysis showed greater overall abundance during presentation to be associated with increased error. It is concluded that training, rehearsal strategy and task specific factors have differential effects on the relationship between the EEG and recall performance.

- 004 Jones, D. M., Gale, A., & Smallbone, A. Short term recall of 9-digit strings and the EEG III: Basal and within-task correlates of diurnal variation in performance. British Journal of Psychology (awaiting decision).

The EEG of twenty subjects was measured before, during and after presentation of 24 trials of 9-digit strings for immediate recall. Subjects attended on two occasions, a morning and evening session, in a balanced design. Recall was superior for both the second visit and evening sessions. Delta, high alpha and beta EEG abundance was greater in the evening, while low alpha was smaller. Various EEG measures showed session effects (visits), before and after task effects, and relationships with performance. All supra-theta frequencies showed a digit-presentation effect. Different EEG frequencies show some functional differentiation within the data and it is suggested that variation in different EEG frequencies may reflect activity in different brain centres and have differential functional relationships with separable sources of arousal.

- 005 Jordan, S. Physiological indices of a simple cognitive task (Report No. TN-8). Orlando, Fla.: Naval Training Equipment Center, Human Factors Laboratory, February 1973.

The purpose of the study was to determine the usefulness of skin resistance and other physiological measures as indicators of a simple cognitive ability such as the immediate recall of digits. Subjects were placed in a sound attenuated chamber and wired for heart rate and skin resistance recordings. The task involved immediate recall of a 10 alternative digit sequence and a two digit alternative sequence. Results indicated no statistically significant relationship between physiological measures of alertness (skin conductance and heart rate) and a simple cognitive task (digit recall). Further experimentation is required to resolve ambiguity of results; in particular, a design is needed in which task difficulty and task duration are systematically varied over several points over a wide range.

- 006 Jovanovic, U. J. Die subklinische Schlafaktivität im EEG. [Subclinical sleep activity in the EEG.] Psychiatria Clinica, 1969, 2, 338-367.

By 'subclinical sleep activity' in the EEG the author means the appearance of sleep-associated features appearing in the waking EEG without clinical concomitants of sleep, and which disappear on hyperventilation, sensory stimulation, waking-drugs and sleep. Following the usual procedure for sleep recordings the subclinical sleep activity can also be divided into state A and B. The state A contains the substate Aa in which the subclinical sleep activity is not yet recognisable; the substate Ab shows continuous and regular alpha waves without changes in frequency or amplitude; the substate Ac shows flat EEG rhythms. The subclinical sleep activity in state B can be subdivided into substate Ba with smaller and faster theta waves, and the substate Bb with medium-frequent theta waves of 4-5c/sec. In the substate Bc clinical sleep appears.

Similar low voltage or 4-5c/sec rhythms were earlier described by GIBBS, GIBBS and LENNOX; PINE and PINE; PITOT and GASTAUT; NAYRAC and BEAUSSART; VALLAT and LEPETIT; VOGEL and GOTZE and others in connection with cerebral traumata and in abnormal personalities. The definition of subclinical sleep activity in the EEG however does include only those rhythms which can be turned into a normal alpha rhythm by the above mentioned provocative methods.

The author found 82 persons with subclinical sleep activity in a total of 1,059 probands (7.74%). All probands were investigated by resting EEG, hyperventilation, sensory stimulation and waking-drugs. Fourteen cases were also observed during several nights while polygraphic recordings were made during natural sleep.

- 597 Jus, A., & Jus, C. Etude de l'extinction par repetition de l'expression EEG du reflexe d'orientation et de l'action du frein externe sur les reactions EEG aux differents stimuli chez l'homme. [Study of the extinction by repetition of the EEG expression of the orienting reflex and of an external inhibitor on EEG reactions to different stimuli in man]. Electroencephalography and Clinical Neurophysiology, 1960, Supplement 13, 321-333.

Influence of the external inhibitor on EEG reactions to different stimuli (visual, auditory, tactile) has been studied in 20 normal adults. The experiments were carried out in the state of vigilance and somnolence or sleep after an injection of chlorpromazine.

In many cases no correlation was found between the EEG reaction and subjective sensation in the study of attention. In some cases however, in which the EEG reaction to an exteroceptive stimulus "a" preceded by an intense stimulus "b" (external inhibitor) was absent, the subjective sensation of the stimulus "a" was either diminished or absent.

- 598 Jus, K., Kiljan, A., Kubacki, A., Rzepecki, J., Wilczak, H., & Jus, A. Studies on the effect of psychological factors on the "expectancy wave". Polish Medical Journal, 1968, 7, 1235-1241.

The authors have confirmed in a series of experiments the findings of Walter and other authors on the appearance of an "expectancy wave" in cases where the conditioned stimulus was reinforced by an imperative stimulus.

The authors have observed the appearance of an "expectancy wave" also in cases where the reinforcement by an imperative stimulus was absent and the subject was only instructed to adopt after the conditional stimulus an "expectancy attitude" towards a reinforcement which is well known and has no imperative meaning.

K

- 000 Kahneman, D. Attention and effort. Englewood, NJ: Prentice-Hall, 1973.

Theoretical and empirical data pertaining to attention and mental effort are reviewed and discussed. Physiological correlates of these processes are also reviewed. Topics covered include:

1. Basic issues in the study of attention.
2. Toward a theory of mental effort.
3. Arousal and attention.
4. Looking
5. Attention and perception.
6. Attention to attributes.
7. Focused attention - findings and theories.
8. Attention divided among inputs.
9. Speeded responses to simultaneous and immediately successive signals.
10. Attention and task interference.

- 000 Kahneman, D., & Beatty, J. Pupil diameter and load on memory. Science, 1966, 154, 1583-1585

During a short term memory task, pupil diameter is a measure of the amount of material which is under active processing at any time. The pupil dilates as the material is presented and constricts during report. The rate of change of these functions is related to task difficulty.

- 001 Kahneman, D., Peavler, W. S., & Onuska, L. Effects of verbalization and incentive on the pupil response to mental activity. Canadian Journal of Psychology, 1968, 22, 186-196.

Measurements of pupil size were obtained during performance of a short-term memory task (Add-0) and a digit-transformation task (Add-1). In Experiment I, Ss either repeated their answer twice (say) or thought the answer first then said it aloud once (think). Small dilatations occur on the first utterance of a digit string. In Experiment II, the risk associated with the task was varied by monetary incentive and penalty. High incentive only increases the pupil response to the easier task. In both experiments the largest effects were associated with task difficulty. The results confirm the validity of pupil measures as indicators of the load imposed by mental activity.

- 602 Kahneman, D., Tursky, B., Shapiro, D., & Crider, A. Pupillary, heart rate, and skin resistance changes during a mental task. Journal of Experimental Psychology, 1969, 79, 164-167.

The Ss performed a paced mental task at three levels of difficulty, while time-locked recordings of pupil diameter, heart rate, and skin resistance were made. A similar pattern of sympatheticlike increase was found in the three autonomic functions during information intake and processing, followed by a decrease during the report phase. The peak response in each measure was ordered as a function of task difficulty.

- 603 Kaiser, D. N., & Sandman, C. A. Physiological patterns accompanying complex problem solving during warning and nonwarning conditions. Journal of Comparative and Physiological Psychology, 1975, 89, 357-363.

Physiological responses of 48 subjects were studied during both a warning and a nonwarning condition and during anagram problem solving. The warning condition was associated with heart rate deceleration and increased occurrence of galvanic skin responses (GSR), of skin conductance, and of tonic galvanic skin potentials (GSP). The warning condition also resulted in significantly faster solution rates. Problem solving was associated with increases in heart rate, occurrence of GSR, and skin conductance. The occurrence of phasic GSP habituated, but the occurrence of tonic GSP maintained a significant response frequency. Large increases in tonic GSP, with minimal phasic increases during problem solving, reflected the bidimensionality of electrodermal activity as a function of the task. These findings were interpreted to support Lacey's hypothesis of response fractionation and suggest the utility of physiological measures in the study of putative attentional functioning.

- 604 Kakigi, S., & Imashioya, H. Effects of foreperiod interval upon reaction time, alpha blocking, and heart rate under variable conditions with reduced learning factors. Acta Psychologica, 1972, 36, 459-470.

Investigated the effects of foreperiod interval upon reaction time (RT), alpha blocking, and heart rate (HR) in 20 college students under conditions in which learning factors and conditional probability were minimized. Ss were given a series of 44 randomized foreperiod intervals (0-30 sec). The fastest RT was obtained at .6-sec foreperiod. Alpha blocking provided the same trend as that of RT, showing that the .6-sec foreperiod yielded the largest alpha blocking. Positive correlation was observed between the speed of RT and alpha blocking ($r = .56$, $p < .001$). HR curves were different from those of RT and alpha blocking. No significant correlation was obtained between RT and HR. Results are discussed, in terms of the theory of classical conditioning.

- 605 Kalafat, J. D. The relationship between signal detection and magnitude of heart rate deceleration (Doctoral dissertation, University of Colorado, 1970). Dissertation Abstracts International, 1971, 32, 1242B-1243B. (University Microfilms No. 71-21, 598.)

The purpose of the present experiment was to investigate the relationship of cardiac deceleration to stimulus reception.

Thirty subjects were given an auditory detection task during which their heart rate was monitored. The stimulus consisted of a warning tone, followed by a time interval and then a one-second burst of noise in which occurred the stimulus tone. The average deceleration initiated in attention tasks lasts approximately nine seconds. Therefore, in order to manipulate heart rate level, two time intervals between warning tone and stimulus were provided. A stimulus occurring eight seconds after the warning tone was predicted to occur during the nadir of the deceleration response, while a stimulus occurring three seconds after the warning tone was predicted to occur during the initial stages of the deceleration response. The warning tone serves as a signal for the subject to attend and can also provide information as to the difficulty of the attention task. Hence, in order to manipulate subjects' expectancy and hence effort to detect the stimulus, two warning tones were provided. A relatively loud warning tone told subjects to expect a relatively loud (easy to detect) stimulus tone; a relatively soft warning tone told subjects to expect a relatively soft (difficult to detect) stimulus tone. The stimulus tone was present on half of the trials, while a burst of noise which contained no stimulus tone was present on the other half of the trials. Subjects were required to press a key indicating the probability of the occurrence of the stimulus tone on a given trial.

The results of the experiment indicate that cardiac deceleration level is positively related to the subject's effort to detect the stimulus. Significantly more decelerations occurred to the warning tone indicating the relatively difficult detection task than to the warning tone indicating a relatively easy detection task. Significantly more false positives occurred during periods of smaller cardiac decelerations. No relationships were found between cardiac decelerations and sensitivity or criterion level. These results raise some doubt as to the generality of Lacey's hypothesis concerning the facilitative effect of cardiac decelerations in attentional processes.

- 606 Kalsbeek, J. W. H. Measurement of mental work load and of acceptable load: Possible applications in industry. International Journal of Production Research, 1968, 7, 33-45.

In experiments to assess mental work load the effect of the central choice making system being the weakest link is demonstrated, using a binary choice generator. It was found that increasing the number of binary choices per minute diminished the irregularity of the rest pattern (Sinus Arrhythmia) without affecting the level of heart rate.

A simple scoring method for the use of sinus arrhythmia is put forward and different tasks are scaled according to the progressive suppression of sinus arrhythmia. Referring to experiments showing that the central choice making mechanisms are operating as a single channel, the "method of distraction stress" is introduced. The deterioration of experimental performance by this method is described and compared with the deterioration caused by other sources of stress.

Finally the concepts of reserve-capacity and "willing-to-spend" capacity are discussed.

- 607 Kalsbeek, J. W. H. Sinus arrhythmia and the dual task method in measuring mental load. In W. Singleton, J. Fox & D. Whitfield (Eds.), Measurement of man at work, London: Taylor & Francis, 1971.

The heart rate pattern of normal healthy subjects sitting at rest is irregular. Momentary irregularity of up to ten or fifteen beats per minute can occur. In the medical literature this phenomenon is generally referred to as sinus and respiratory arrhythmia. If one concentrates one's attention on a perceptual motor task the irregularity of the heart rate pattern tends to disappear as a function of the number of signals per minute one has to deal with. The mean heart rate, however, changes little if at all.

- 608 Kalsbeek, J. W. H. Standards of acceptable load in ATC tasks. Ergonomics, 1971, 14, 641-650.

Mental load in ATC tasks is described as the brain controlling the controller's controlling performance. A moment of conscious brain control is put forward as a unit to quantify this kind of mental load. New action programs are supposed to require conscious brain control at every step of their execution; with routine this would be less and less the case. The duration of a moment of conscious control varies according to the complexity of the control to be exercised and the number of considerations which have to be taken into account. Propositions are made on how to think about selective attention, identification and cognitive processes in terms of executing programs. A job description method is put forward in terms of such executing programs.

Why moments of conscious brain control as units are more suited to the problem of mental load than are units like bits, choices and decisions is discussed.

Experiments are described with physiological and psychological variables as a function of the number of moments of conscious brain control per minute.

609 Kalsbeek, J. W. H. Do you believe in sinus arrhythmia? Ergonomics, 1973, 16, 99-104.

Some problems raised by the use of heart rate irregularity as a dependent variable in experiments are mentioned. Referring to experimental results it is argued that mental load is not an indivisible concept. In laboratory studies a binary choice task is often used in order to provide the level of mental load as an independent variable.

This kind of task is dependent on the capacity of the single channel function. Other types of informational load are conceivable. Special attention is given to the phenomenon of peak load. Finally, heart rate variability is accepted as an indicator of the proportional occupation of an individual's single channel capacity during rest and work. A plea is made that it is necessary to be very careful in using terms like the sinus arrhythmia and the mental load and in using heart rate variability in field applications.

610 Kalsbeek, J. W. H., & Ettema, J. H. Continuous recording of heart rate and the measurement of perceptual load. Ergonomics, 1963, 6, 306-307. (Abstract)

The fact that the irregularity is gradually suppressed when increasing the difficulty of the task, suggests that it could possibly be used for measuring perceptual load.

A simple scoring is proposed. Recordings of six subjects obtained under different conditions were compared with recordings during a rest period preceding each test.

Perceptual performance, noise and opened eyes as opposed to closed eyes, tend to suppress the so-called sinus arrhythmia.

Concluding, it can be argued that the suppression of sinus arrhythmia deserved consideration as a possible arousal phenomenon.

611 Kalsbeek, J. W. H., & Ettema, J. H. Physiological and psychological evaluation of distraction stress. Proceedings of the Second International Congress on Ergonomics, 1964, 443-447.

In experiments in which the speed of a serial binary choice task was systematically varied, Kalsbeek and Ettema found that suppression of sinus arrhythmia changed as a function of the number of signals per minute. This might lead to the hypothesis that the suppression of sinus arrhythmia in the minus condition (reluctance to spend reserve capacity) would be less than is the case in the plus condition. In this case the suppression of sinus arrhythmia varied with the supposed experimentally induced fluctuations in the 'willing to spend capacity'. In a pilot study however several subjects found it hard to obey the instruction of the minus condition accepting the break-down of their writing performance before it was strictly necessary. Further experiments are in progress. This study only seeks to contribute to the discussion on the theoretical background of experimenting with the dual task method.

- 612 Kalsbeek, J. W. H., & Ettema, J. H. L'arythmie sinusale comme mesure de la charge mentale. [Sinus arrhythmia as a measure of mental load.] Actes du Troisieme Congres de la Societe d'Ergonomie de Langue Francaise, Bruxelles: Presses Universitaires de Bruxelles, 1968, 251-258.

The results reported in this article appear to indicate that the progressive diminution and suppression of sinus arrhythmia reflects the mental load imposed by task demands. The authors present a scale relating arrhythmia to mental load.

- 613 Kalsbeek, J. W., & Sykes, R. N. Objective measurement of mental load. Acta Psychologica, 1967, 27, 253-261.

It is hypothesized that distraction stress can simulate the effects of other kinds of stress insofar as these effects lead to reducing the information handling capacity. A simple repetitive task serves to distract systematically the S from his carrying out a normal task by occupying his information handling capacity. The best physiological parameter found was the scored regularity of the heart rate pattern. In addition, the following aspects of the dual task situation as such are studied: (1) the effect of training and instructions, and (2) the effect of increasing demands in the primary task in a dual task situation on the total capacity spent at the performance of both tasks and the suppression of sinus arrhythmia measured by the tolerance method of Kalsbeek and Ettema.

- 614 Kamishiro, M., Saito, K., & Takakuwa, E. Optimal performance in conveyer systems from a viewpoint of the physiological functions (In Japanese) Japanese Journal of Ergonomics, 1973, 9, 207-214.

The optimal performance was studied on the inspection and vigilance tasks for measuring steel pins. The subjects were eight healthy male students. Four of them measured the diameter of steel pins in conveyor system as well as in non-conveyor system (inspection task group). The other four watched the performance of the above inspection task (vigilance task group). In conveyor system, both groups were engaged in their tasks for 30 min and 120 min under three different conditions as 20 cm, 30 cm and 40 cm of the station-interval between the steel pins. In non-conveyor system, they were engaged in their tasks for 120 min only.

The results were as follows:

1) The performance on the inspection and vigilance tasks in non-conveyor system was significantly better than that in conveyor system.

2) In conveyor system, both inspection and vigilance tasks were performed most effectively at the station-interval of 30 cm.

3) The TAF (the function of concentration maintenance) and FF (flicker frequency) tests showed that the body burden in vigilance task was greater than that in inspection task.

- 616 Karimova, M. M., & Volkova, I. M. [Comparative study of the state of the cardio-vascular system in engineers working on different electronic computers.] (In Russian) Proceedings of a Symposium on Ergonomics in Machine Design, jointly organized by the Czechoslovak Medical Society J. E. Purkyne and ILO, Prague, 2-7 October 1967, ILO, Geneva, 1969, 1, 325-332.

Studies of the state of the cardio-vascular system during a working day and a working week among engineers working on large digital and analogue electronic computers revealed the greatest shifts of the parameters of ECG and blood pressure in the engineers working on digital computers. An explanation may be that mental-emotional stress factors are expressed more strongly in this group owing to the greater complexity of these computers and some other features. These shifts are expressed in the progressive decrease of the peak T_2 towards the end of the working day, up to its inversion in individual cases; the discordancy of the changes in the direction of the peaks T_2 and R_2 ; the lengthening of Q-T in comparison with the normal. The indices of the average dynamic blood pressure do not exceed the age-standard limits, and are stable in the working day, but fall considerably towards the end of working week (15-17 mm Hg). In the group of engineers working on the analogue computers indices of ECG and blood pressure are almost stable over both the working day and the working week.

- 616 Karlin, L. Cognition, preparation, and sensory-evoked potentials. Psychological Bulletin, 1970, 73, 122-136.

Experiments reporting enhancement of averaged sensory-evoked potentials resulting from the effects of various cognitive aspects of stimulation are reviewed and reinterpreted in terms of two hypotheses which refer, respectively, to (a) development of preparation before and (b) reactive change in preparation after presentation of critical stimuli. The possibility is examined that certain slow voltage changes, such as contingent negative variation and other so-called "readiness" potentials, are associated with reactive change and produce the positive enhancement in evoked potentials as reported in many of these experiments.

- 617 Karlin, L., & Martz, M. J., Jr. Response probability and sensory-evoked potentials. In S. Kornblum (Ed.), Attention and performance IV. New York and London: Academic Press, 1973.

Evoked potentials to stimuli conveying various amounts of response information as measured by a priori response uncertainty were studied in an experiment in which information was delivered either 1 sec before (condition W) or at the time when (condition N) a fast choice response was required. Increase in response information produced enhancement of P_3 beyond that of a rare-stimulus control in both conditions, but the effect was greater in condition N. The overall size of P_3 was also greater in this condition. It was concluded that P_3 enhancement was indirectly related to the cognitive aspects of stimulation through the mediation of momentary or "phasic" arousal factors.

- 618 Karlin, L., Martz, M. J., Brauth, E., & Mordkoff, A. M. Auditory evoked potentials, motor potentials and reaction time. Electroencephalography & Clinical Neurophysiology, 1971, 31, 129-136.

Determined separately evoked potentials from simple and choice (RT) tasks for trials in the fast, middle, and slow 3rds of the RT distributions. Results with 12 undergraduates show that those trials with faster RT also produced a more negative N1 peak, less negative peak at N2 and N3, and more positive peaks at P3 and P4; the choice task also produced significantly larger deflections at N1 and P3 than did the simple task. In the choice RT condition, the stimuli that did not require a motor response (S-) yielded a P3 deflection slightly greater than that produced by the response stimuli (S+) in the fast 3rd of the RT distribution, whereas the S- stimuli produced an N1 deflection approximately equal to the corresponding deflection produced by S+ in the middle 3rd of the RT distribution. This difference between N1 and P3 was interpreted to mean that they were partially independent in that the amplitudes of both deflections were influenced by changes in background arousal, whereas only P3 was influenced by a reactive factor. Various types of analyses suggest that response time and previously hypothesized response-related potentials could not have been responsible for any of the results obtained.

- 619 Karlin, L., Martz, M. J., & Mordkoff, A. M. Motor performance and sensory-evoked potentials. Electroencephalography and Clinical Neurophysiology, 1970, 28, 307-313.

Averaged evoked potentials (EP) to tones were determined for fifteen subjects in three tasks which were designed to evaluate the effects of motor response, of withholding a response and of different response latencies. With the influence of eye movement minimized, it was found that the various deflections of the sensory EPs were affected differently as follows:

1. Withholding a response produced a significantly larger P₃ deflection. The amplitude of this deflection was negatively correlated with reaction time (RT).
2. Stimuli to which overt motor responses were subsequently made produced a negative shift in deflections N₁, P₂ and N₂, but there were no significant changes in deflections P₁, P₃ and N₃.
3. No effects which could be ascribed to specific time characteristics of the tasks (e.g., simple versus choice RT) were found and no effects could be attributed to the overt motor response or its immediately preceding EMG activity.

The data were interpreted to mean that the negative shift in N₁, P₂ and N₂ is related to the development of an excitatory state associated with the intention to respond to the stimulus and that increased positivity in P₃ is uniquely related to the act of withholding a response to the stimulus when rapid action is required. No effects on the averaged EP were observed that could be attributed unequivocally to occurrence of overt motor response itself.

- 620 Karrer, R., Kohn, H., & Ivins, J. Effects of varying the stimulus and response contingencies on the CNV. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 39-43.

It is evident from these data that the unexpected occurrence of a shift to 50% S_2 plus R after training on 100% S_2 plus R gives an increase in CNV amplitude. This finding confirms our first hypothesis that uncertainty leads to heightened attention, thereby giving larger CNVs. Complete omission of S_2 plus R (100% SE) is quite effective in reducing the CNV amplitude and within-subject variability. Our second hypothesis is confirmed by the fact that response ineffectiveness (100% RE) reduces CNV amplitude, even though S_2 is always present. This finding implicates motivational variables related to S's knowledge of his control of S_2 and supports the Peters et al. (1970) interpretation of their results. The increased within-subject variability in the 100% RE group suggests that complete response ineffectiveness leads to increased change in motivation from trial to trial. Since steady potential levels were not affected after the feedback of information, it is indicated that feedback effects are primarily exerted within the $S_1 - S_2$ interval. It is of interest that 50% RE always has lower CNVs than 50% SE (although not significant) even though S_2 is always present. Apparently, the reduced motivation from 50% response ineffectiveness counteracts some of the heightened attention produced by the uncertainty of the 50% SE schedule, which indicates an interaction between motivation and attention on CNV amplitude. Further work should examine the role of motivation (set) and uncertainty in the large individual differences found in the CNV amplitude.

- 621 Karrer, R., Kohn, H., & Ivins, J. Large steady potential shifts accompanying phasic arousal during CNV recording in man. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 119-124.

The results of our experiments with artifactual controls point to a cerebral origin for these large SPSs. Ample research on humans and animals (Caspers 1963; Sano et al. 1967) supports a cortical basis for large slow potential shifts.

The lack of relation between SPSs and specific EEG frequencies is in keeping with reports by Caspers (1963) and Rowland (1968) of the relative independence between classic EEG frequency indications of arousal and SPSs. The latter appear to be more sensitive signs of behavioral arousal.

These large SPSs seem analogous to those that accompany phasic increases (negative SPS) and decreases (positive SPS) of arousal in rats and cats (Caspers 1963; Rowland 1968). They fall along an amplitude and duration continuum of steady potential shifts that are sensitive indices of behavioral state and orienting. This continuum may range from small orienting SPSs and CNVs through phasic arousal shifts described here to even larger and slower base level drifts during the sleep-wakefulness cycle. The large SPSs seem independent but not mutually exclusive of CNV occurrence. They may obscure or interact with the CNV. Our analyses indicate some manipulation of the occurrence of the SPSs by our experimental conditions, but further specification of variables is needed to bring them under precise control. Variables that seem of importance are motivation (response urgency), the focus of the S's attention on external or internal events, the S's certainty for occurring stimulus events, and steady potential base level.

- 622 Karsh, R. Relationship between galvanic skin resistance and reaction time on a visual monitoring task (Technical Memorandum 8-61). Aberdeen Proving Ground, Md.: Human Engineering Laboratories, May 1961.

Interrelationships among galvanic skin resistance indices as well as mean reaction time changes over time were consistent with earlier reports on these variables.

No significant relationships were found between indices of galvanic skin resistance and reaction time, between or within observers. Extreme individual variation of both variables was observed.

- 623 Kaufman, D., Gibson, D., & Adamowicz, J. K. Heart rate change under variable auditory and mental task conditions. Psychonomic Science, 1967, 9, 471-472.

Twenty-seven Ss performed for 2 difficulty levels of a Lacey silent elaboration type of mental task against 3 auditory background conditions. Results were evaluated for magnitude and direction of heart rate change with respect to the task difficulty and auditory conditions. Findings supported the suggestion that cardiovascular augmentation serves to sustain attention level appropriate to solution of a given task and that more difficult mental work will elicit less cardiac supplementation than easy mental work. Interpretation was given in terms of activation theory.

- 624 Keefe, F. B., Johnson, L. C., & Hunter, E. J. EEG and autonomic response pattern during waking and sleep stages. Psychophysiology, 1971, 8, 198-212.

The response hierarchy of EEG and autonomic variables to tones of increasing intensity was studied during waking and sleep stages 2, REM, and SW (3 & 4 combined). Tones of 1000 Hz (5 sec duration, 55 sec ISI) were presented to 35 young adult male subjects. During waking, the tones began below awake auditory threshold and increased by 5 db until a motor response (button press) was made. During sleep, tones began at awake threshold and went to arousal threshold, i.e., motor response and/or an EEG change indicative of arousal. Changes in EEG, finger pulse amplitude, heart rate, skin potential, skin resistance, and respiration period were measured for each stimulus and were compared to a pseudostimulus response scored 25 sec prior to the actual stimulus.

In the awake state, statistically significant responses ($p < .05$) were found for EEG, finger pulse, heart rate early deceleration, skin potential, and skin resistance to the tone at awake threshold, but not to tones at lesser db levels. During sleep, significant EEG responses were present to tones 30-25 db below arousal threshold, finger pulse 20-15 db below, and heart rate acceleration 20-5 db below. Significant skin potential, skin resistance, and motor responses were seen only at arousal threshold. Thus, in sleep, in contrast to waking, there were clear responses to stimuli below the arousal threshold, and there was definite ordering of the appearance of the various responses: EEG preceded the cardiovascular, with electrodermal and motor occurring only at arousal. This order was constant over sleep stages.

Arousal thresholds were very similar across sleep stages in day sleepers (approximately 35 db above awake threshold). The threshold during stage 2 for night sleepers was about 15 db lower than that for day sleepers.

- 625** Keesey, U. T., & Nichols, D. J. Fluctuations in target visibility as related to the occurrence of the alpha component of the electroencephalogram. Vision Research, 1967, 7, 859-877.

Under stabilized image viewing conditions, alpha onset and termination precede respectively the report of disappearance and reappearance of the image. When a pattern of visibility is imposed on the same target viewed normally, either by defocusing or dimming it, alpha onset and termination generally follow the report of image fading and regeneration. Spontaneous fluctuations in the visibility of a normally viewed target is obtained at low luminance levels, but alpha shows no clear temporal relation to image disappearance and reappearance.

Temporal alpha occurrence patterns are found to be similar when a low or high luminance target is viewed normally. Stabilized presentation of the target changes the temporal characteristics of alpha occurrence. A correlation between image visibility and alpha occurrence pattern is found only when the image is stabilized or the luminance of a normally viewed image is periodically decreased.

It is proposed first that temporal patterning of alpha activity reflects the presence or absence of stimulation provided by image motions; and secondly, that fluctuations in the visibility of a stabilized image are controlled by the spontaneous fluctuations in the resting activity level of cortical structures.

- 626** Kennedy, J. L. Some practical problems of the alertness indicator. In W. F. Floyd & A. T. Welford (Eds.), Symposium on fatigue. London: Lewis, 1953.

Drugs, such as benzedrine, have been proposed to increase alertness and there are good reasons for adopting this technique rather than any method requiring expensive apparatus and special training.

But the most serious practical problem of all seems to be, "Is protection against lapses in alertness a serious enough problem for anyone to worry about?" I confess to having mixed feelings on this issue. I suppose that this question is similar to the life insurance problem. How much are you going to be willing to pay for protection against something that may never happen, for which we have only the support of accident statistics. Most of the time, accident statistics only tell us that accidents happen and not where to pin the blame. Is alertness a problem out in the real world of human affairs?

- 627** Kennedy, J. L., Gottsdanker, R. M., Armington, J. C., & Gray, F. E. A new electroencephalogram associated with thinking. Science, 1948, 108, 527-529.

The following summary statements may be made:

(1) An intermittent spindle-shaped electroencephalogram with a frequency of 8-12c/sec and a maximum amplitude of 20-30 microvolts has been recorded from bipolar electrodes placed just back of the external canthi of the eyes.

(2) These bursts appear to be associated with the process of thinking (discrimination, choice reaction, mental arithmetic, problem solving, etc.).

(3) The bursts are unrelated to previously described alpha activity.

(4) Half of the subjects so far tested exhibit the phenomenon.

(5) It is suggested that the source of the new EEG may be the temporal lobes of the brain.

- 620 Kennedy, J. L., & Travis, R. C. Prediction of speed of performance by muscle action potentials. Science, 1947, 105, 410-411.

By the use of a new electronic counting technique a rather remarkable relationship has been found between reaction time to aperiodic stimuli in a monotonous situation and frequency of muscle action potentials (recorded from bipolar electrodes placed above the eyes) during a 6-second interval before the onset of the stimuli.

It is believed that these techniques may make it possible automatically to warn personnel engaged in monotonous tasks, such as truck driving, before dangerous conditions of inalertness and approaching sleep occur.

- 620 Kennedy, J. L., & Travis, R. C. Prediction and control of alertness: II Continuous tracking. Journal of Comparative and Physiological Psychology, 1948, 41, 203-210.

1. From experimental results on a new electronic accumulator, using a continuous, attention-demanding tracking task, different levels of alertness were significantly related to muscle potential output. Levels of alertness were measured by reaction time and adequacy of tracking performance.

2. The lower the muscle spike emission, in general, the slower the reaction time and the poorer the tracking score.

3. Reaction time and tracking score were significantly related as measures of performance.

4. Great variability in the range and average tension level between individuals throughout the experimental period was found.

5. In general, tension level and adequacy of performance exhibited an inverse relationship.

- 630 Kibler, A. W. The relationship between stimulus-oriented changes in heart rate and detection efficiency in a vigilance task (Doctoral dissertation, The University of Michigan, 1967). Dissertation Abstracts, 1968, 28, 5218B-5219B. (University Microfilms No. 68-7644). Also available as Report No. 67-233, Wright -Patterson Air Force Base, Ohio: Aerospace Medical Research Laboratories, Aerospace Medical Division, Air Force Systems Command, February 1968.

The purpose of this study was to assess, in a vigilance context, the relationship between detection efficiency and beat-to-beat changes in heart rate around task stimuli. Thirty six subjects, instrumented to permit continuous recording of EKG and respiration, individually stood a 96 minute vigil. Their task was to monitor a light which flashed on (stimulus event) for 500 ms once every 6.0 seconds and to report occasional brighter flashes (signals). One half of the subjects (high signal density group) received 240 signals during the vigil; the remaining 18 subjects (low signal density group) received but 16 signals during the vigil. By verbal admonishment, urging the subjects to do their best, a motivational condition was induced during a six minute post-test. The results, in terms of detection efficiency, are in accord with previous research. Detection efficiency was higher and better sustained by the high signal density group. The low signal density group detected fewer signals and their detection efficiency decayed appreciably over time. During the motivational post-test condition the performance of both groups improved significantly. Measures of changes in heart rate, analyzed both in terms of overall shifts in heart rate over the vigil and beat-to-beat changes in heart rate around each stimulus event, revealed the following:

1. The median heart rate in succeeding quarters of the vigil, did not differ significantly between the two groups. Nor did changes in overall heart rate correlate significantly with changes in detection efficiency.
2. Heart rate preceding a stimulus event decelerated. Changes in the magnitude of the stimulus-oriented cardiac deceleration showed a low but significant relationship to changes in the percentage of signals detected.
3. In the post-test the significant recovery in detection efficiency was accompanied by an increase in the magnitude of stimulus-oriented cardiac deceleration and by a decrease in overall heart rate.

- 001 Kilpatrick, D. G. Differential responsiveness of two electrodermal indices to psychological stress and performance of a complex cognitive task. Psychophysiology, 1972, 9, 218-225.

Sixteen high trait anxious and 16 low trait anxious male Ss were assigned to a high stress (HS) or a low stress (LS) condition and were given differentially stressful instructions. All Ss were then required to perform a complex cognitive task, the Halstead Category Test. Adjusted indices of tonic and phasic exosomatic electrodermal activity were monitored throughout the experiment. Level of tonic skin conductance (SC) was only minimally responsive to the manipulation of psychological stress but increased greatly during cognitive and perceptual activity. Phasic activity increased significantly following psychological stress but not following cognitive and perceptual activity. It was concluded that these results support a multiple component theory of electrodermal activity. Phasic electrodermal activity appears to increase with psychological as well as physical threat and was suggested to be a good index of autonomic emotional arousal. Tonic SC appears to change mainly as a function of cognitive activity.

- 002 Kinsbourne, M. The cerebral basis of lateral asymmetries in attention. Acta Psychologica, 1970, 33, 193-201.

Asymmetries in the processing of input to either side of the midline are related to hemispheric specialization in man. These asymmetries arise when preponderant activation of one hemisphere biases attention to the contralateral side. This unbalanced cerebral activation is a function of the nature of the subject's task or expectancy. A model of hemispheric integration is proposed.

- 003 Kinsbourne, M. The control of attention by interaction between the cerebral hemispheres. In S. Kornblum (Ed.), Attention and performance IV. New York & London: Academic Press, 1973.

Each cerebral hemisphere guides attention towards contralateral space, and the two hemispheres are in mutually inhibitory balance. In right-handed subjects, the left hemisphere chiefly subserves linguistic processes, and the right hemisphere subserves spatial processes. It is proposed that cognitive activity lateralized to one hemisphere overflows so as to cause contralateral orientational shifts. This model, which can account for laterality effects in perception, is experimentally validated by showing that:

1. Gaze and head turning occur contralateral to the preponderantly active hemisphere when subjects engage in verbal or spatial thought.
2. Concurrent subvocalization (that is, left-hemisphere activity) introduces right-sided advantage into right-handed subjects' ability to detect a gap in a briefly exposed square.
3. Concurrent subvocalization induces right half-field superiority for recognition of briefly presented nonsense shapes by right-handed subjects.

In left-handed subjects, both verbal and spatial processes appear to be programmed from one hemisphere at a given time.

- 884 Kinsbourne, M. The mechanism of hemispheric control of the lateral gradient of attention. In P.M.A. Rabbitt & S. Dornic (Eds.), Attention and performance V. New York: Academic Press, 1975.

When two stimuli in the lateral plane compete for attention, one determinant of the outcome is the relative degree of activation of the two cerebral hemispheres. This activation can be manipulated by imposing tasks that call for the specialized cognitive skills of the target hemisphere (Experiments 1 and 2). Conversely, immediately following an attentional shift, the hemisphere contralateral to the direction of shift is temporarily more efficient than when it is ipsilateral to that direction (Experiments 3 and 4). When one hemisphere has been surgically removed, subjects can still attend to either side of space. But when stimuli compete, the stimulus contralateral to the residual hemisphere is strikingly favoured, even when this is contrary to the subject's intention (Experiments 5 and 6). When the corpus callosum has been divided, fast, fine lateral shifts of attention become difficult to perform, and the lateralization of mental activity has a gross effect on the direction of attention (experiments 7 and 8). We conclude that the direction of attention represents a finely graduated, momentary balance between the opposing turning tendencies of the two cerebral hemispheres.

- 885 Kiriakov, Kr. Nekotorye elektroentsefalograficheskie kriterii utomleniia pri umstvennom trude. [Electroencephalographic criteria of fatigue after mental work.] Zhurnal Vyshego Nerynogo Delatel'nosti, 1964, 14, 412-416. (Aerospace Medicine, 1964, 35, 1236.) (Abstract)

Railroad office personnel whose work requires acute mental concentration, such as dispatchers or telegraph and telephone operators, showed deviations in the electroencephalogram after overtime. The alpha waves disappeared and fast waves, or slow rhythms with superimposed fast waves, were noted. The tracings had an epileptic character of a temporary nature, which disappeared after a period of rest. The author refers to this effect as a heterofunctional phenomenon, which shows a temporary disturbance in the cortical and subcortical region, primarily in the left temporal zone of speech. This could be the result of disturbance of the analytical-synthetic function of the audio-speech and speech-kinesthetic activity of the cortex analyzers. Possibly, the tension lowers the cortex tonus. However, during the ensuing hyperpnea and recovery of neurons to normal state the synchronizing ability is enhanced. Simultaneously general functional changes take place in the organism.

- 690 Kirs, S. P. Human information processing and EEG correlates: The effect of processing strategy and distraction on reaction time and the contingent negative variation. (Doctoral dissertation, University of California, Los Angeles, 1975). Dissertation Abstracts International, 1975, 36, 3112B. (University Microfilms No. 75-26, 965).

The research reported here is based on a revision of the notion of sensory and motor set (Woodworth and Schlosberg, 1954) within the framework of Kahneman's (1973) model of attention and effort and on a new analysis of the effects of distraction. The latter is viewed as a case of divided attention whose disruptive effects will increase or decrease depending on whether processing effort is allocated to input or output functions, respectively. The dependent variables chosen were reaction time (RT) and the contingent negative variation (CNV), a measure of cortical activation at the vertex (Cz) which has been related to attentional processes (Walter et al., 1964; Tacc, 1972).

The main results are that both processing strategy and distraction affect RT and the CNV. Larger negative shifts are associated with an output set, as are faster RTs; however, while the effect of distraction on RT (and also on the number of response errors) is less pronounced under the output set, the CNV attenuates regardless of set. This last result strongly indicates that, while the CNV at the vertex does index cortical activation responsive to changes in processing strategy, other brain systems more sensitive to the predicted interaction of set and distraction must also operate to control RT.

Additional data on the time required to redirect attention denote that the slower RT in the input set is due perhaps entirely to the task of mapping the input data onto the required output. Also presented and discussed are data on changes in the time course of the CNV, on differences in negative shifts at other midline sites (Fz, Pz, and Oz) which suggest that cortical activation in these regions signifies functional processes other than those at the vertex, on negative potentials which occur between the RT and the presentation of feedback (the post-imperative negative variation), and lastly on individual differences as primarily measured by the Stroop Color-Word Interference test (Stroop, 1935; Rose, 1974).

- 691 Kjellberg, A. Sleep deprivation, arousal, and performance. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

The aim of the paper is to provide a theoretical framework within which the performance effects of sleep deprivation (SD) can be interpreted. Primarily, the possibilities and limitation of interpretations in terms of dearousal are evaluated. An interactional view of the relation between SD and arousal is proposed, indicating that the effect of SD is to potentiate the dearousing effect of situational variables. The habituation of the orienting response is suggested as one possible mediator of this effect. The reported attentional effects of SD are shown to be interpretable within this framework. The effects of motivational factors on the SD effects and the SD effect on motivation are discussed, leading to the conclusion that habituation cannot be the only mediator of the dearousing influence of the situation, and that an analysis in operant terms must be added.

- 638 Klein, K. E. Psychophysiologische Belastungsuntersuchungen an einem Instrumenten-Koordination stestgeraet (ICA). [Psychophysiological stress investigations of an instrument-coordination analyzer.] Paper presented at the 14th meeting of the committee "Anthropotechnik" of the Deutsche Gesellschaft für Luft- und Raumfahrt, Munich, November 1973. [Also abstracted in Scientific and Technical Aerospace Reports (Report No. DLR-Mitt 74-19).]

Heart and respiratory rate, skin resistance, and eyelid flicker data were monitored during operation of a pilot selection apparatus allowing complex instrument coordination tasks to find standardized stress-physiological response correlations. Results indicate strong expectation tenseness before tests while, during performance, heart and respiratory rate decrease. Continuous or growing workloads ameliorate heart rate.

- 639 Klein, K. E., Bruner, H., Gunther, E., Jovy, D., Mertens, J., Rimpier, A., & Wegmann, H. M. Psychological and physiological changes caused by desynchronization following transzonal air travel. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

Aspects of the diurnal rhythms of human performance efficiency affected include amplitude, 24-hours level, and phase. In general, the amplitude of the oscillation function was found to diminish; this has also been observed recently by Gerritzen for certain biochemical parameters. In our results this reduction occurred in both performance parameters after both eastward and westward travel; however there was an indication that the alterations were less marked, and of shorter duration after westward flights than after eastward flights. Oxygen consumption and temperature also showed a reduction in amplitude of 30-35% after travelling eastward, whereas travelling in the opposite direction caused changes which might best be described as 'discordant'.

The 24-hours mean performance level was lowered; this was true, also, for oxygen consumption. The decrement was observed for one day after westward and for three days after eastward transportation; but only in the latter case was the change statistically significant. In contrast to these parameters, the 24-hours average of body temperature remained stable. (Nevertheless, there were highly significant postflight alterations in temperature during certain sections of the day. As with the performance measures, these consisted of decreases mainly during 'day' sections, and increases in the 'night' sections.) We consider that these differences in the various parameters in respect of the magnitude of the alterations in the 24-hours mean level support our earlier contention that postflight alterations of performance are induced not only by the disruption of rhythms per se, but also by fatigue produced by other factors both during and after the flight.

- 640 Klein, K. E., Herrmann, R., Kuklinski, P., & Wegmann, H. M. Circadian performance rhythms: Experimental studies in air operations. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

Aircrews operate round the clock and over many time zones. This implies interference of air operations with circadian oscillation of biological functioning as well as with its disruption through shifts of environmental time cues. In this sense the significance of circadian performance rhythms in air operations is discussed. This is done mainly by presenting results from 7 experimental studies in which, before and after transmeridian flights, behavioural and physiological variables were evaluated.

In general, performance was assessed every second post-flight day in three hourly intervals round the clock. Between midnight and 0900 hours subjects were allowed to sleep but were aroused twice for testing for a period of 45 minutes. In all but one study eight healthy male students in the range of 23 to 28 years of age served as subjects; in one experiment ten pilots participated in flight simulator tests.

The results confirmed the idea that alertness, or the readiness to be mentally active belongs to those biological properties of the living organism which are subject to circadian variation. This rhythm persists after transmeridian flights and is de- and resynchronized with the environmental time cues similar to other biological cycles. It so happens that a low performance output temporarily occurs in the local light phase instead of, as usual, in the dark phase. Results given in the pertinent literature reveal an alternating effect on performance of operationally induced fatigue and the circadian rhythm; this interference is of operational significance.

Recommendations for flight scheduling considering circadian rhythm effects are given.

- 641 Klein, K. E., & Wegmann, H. M. Die Resynchronisation Diäner Leistungsrhythmen nach transmeridianen Flügen. [The resynchronization of diurnal performance rhythms after transmeridian flights.] In Aktuelle Forschungsarbeiten aus dem Institut für Flugmedizin. [Current scientific papers from the aerospace medical institute.] (DRL-FB 73-15). Porz, West Germany: Aerospace Medical Institute, January 1973.

In 2 groups of 8 students phase shifts of diurnal performance rhythms were followed after transmeridian flights. The results obtained allow a characterization of differences in resynchronization depending on the flight direction, performance demand, the "chronobiologic" nature of the tested function and on the mode of activity of the subject after the flight.

- 642 Klein, K. E., Wegmann, H. M., Athanassenas, G., Hohlweck, H., & Kuklinski, P. Air operations and circadian performance rhythms. In B. O. Hartman (Ed.), *Higher mental functioning in operational environments. AGARD Conference Proceedings*, No. 181, 1976. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365, Attn: Report Distribution and Storage Unit)

This paper reviews our own experimental results and pertinent data from literature on circadian behavioural rhythms and its modifications through various factors. It relates them to the operation of aircrews "round the clock" and on transmeridian routes and discusses some possibilities of an appropriate scheduling. Concurrent changes in a number of physiological variables are also presented.

- 643 Kleinman, K. M. The role of task complexity in the demonstration of the relationship between peripheral physiological measures and performance. (Doctoral dissertation, Washington University, 1967). *Dissertation Abstracts*, 1967, 28, 1229B. (University Microfilms No. 67-9399)

Independent groups of college students were tested on either a simple or somewhat more complex reaction time task. The stimulus elements of both tasks consisted of two warning and two reaction time signals. As one group was instructed to respond only to certain combinations of these stimuli, while the other group responded to any combination, the former task was defined as more complex. For both groups, the warning and reaction time signals also served as conditioned and unconditioned stimuli, respectively, in a classical conditioning paradigm. Reaction time was the performance measure and various measures of skin resistance were correlated with it. The latter also served as the system in which conditioning was measured.

Of the variety of skin resistance measures taken, the number of both spontaneous fluctuations and orienting responses correlated significantly with reaction time, but only on the more complex task. On both tasks, however, physiological measures correlated with the frequency of skin resistance conditioned responses.

It was concluded that, regardless of the particular theoretical approach one adopts concerning the nature of the relationship between physiological measures and performance, at least a moderate degree of task difficulty is necessary to demonstrate any relationship at all.

- 644 Kleinman, K. M., & Stern, J. A. Task complexity, electrodermal activity and reaction time. *Psychophysiology*, 1968, 5, 51-60.

Forty Ss, divided into 2 groups, performed either a simple or complex fixed foreperiod RT task. Various measures of skin resistance were taken before and during performance of the task. Only on the more complex task were electrodermal measures related to RT. However, the sign of the relationship was opposite to that found in other investigations: Ss with many spontaneous fluctuations and orienting responses reacted slowly. The results were interpreted in terms of the influence of both task complexity and foreperiod characteristics.

- 645** Kleinsmith, L. J., & Kaplan, S. Paired-associate learning as a function of arousal and interpolated interval. Journal of Experimental Psychology, 1963, 65, 190-193.

This experiment tested the hypothesis that due to the phenomenon of perseverative consolidation, a pattern perceived under high arousal should show stronger permanent memory and weaker immediate memory than a pattern accompanied by low arousal. While recording skin resistance as a measure of arousal, 48 Ss were presented 8 paired associates for learning. The Ss were tested at various time intervals: 2 min, 20 min, 45 min, 1 day, and 1 week. The results confirmed the hypothesis ($p = .001$). Paired associates learned under low arousal exhibited high immediate recall value and rapid forgetting. High arousal paired associates exhibited a marked reminiscence effect, that is, low immediate recall and high permanent memory.

- 646** Kleinsmith, L. J., & Kaplan, S. Interaction of arousal and recall interval in nonsense syllable paired-associate learning. Journal of Experimental Psychology, 1964, 67, 124-126.

Using meaningful paired associates as stimuli it has been shown previously that due to the phenomenon of perseverative consolidation high arousal associates show stronger permanent memory and weaker immediate memory than low arousal associates. The present experiment was designed to show that this phenomenon is independent of the association values or unique qualities of the words involved. While recording skin resistance as a measure of arousal, 36 Ss were presented 6 (0% association value) nonsense syllables paired with single digit numbers. Ss were tested at 2 min, 20 min, or 1 week. The results confirmed the hypothesis ($p = .01$). Nonsense syllable paired associates learned under low arousal exhibited high immediate recall and rapid forgetting. High arousal associates exhibited a marked reminiscence effect, low immediate recall and high permanent memory.

- 647** Kleitman, N. Physiological cycling. In B. E. Flaherty (Ed.), Psychophysiological aspects of space flight. New York: Columbia University Press, 1961.

In the studies of artificial rhythms referred to, it was shown that the longer the cycle, the greater the body temperature range. This means that one can expect to reach a greater degree of alertness and a higher level of performance, on the one hand, and a more complete relaxation, perhaps better sleep, on the other. The exact length of the period finally adopted would depend upon the ultimate wakeful capacity of the space travelers, to be determined by actual trial of cycles of varying duration.

- 648** Kleitman, N., & Jackson, D. P. Body temperature and performance under different routines. Journal of Applied Physiology, 1950, 3, 309-328.

Diurnal body temperature curves of 9 male adults were modified, in a few days, to conform to a variety of experimental activity schedules. The less the deviation from the usual routine, the better was the adjustment. No change in the usual diurnal body temperature curve occurred on a rotating activity routine.

Color naming, and to a lesser extent reaction time and Link Trainer operation, showed a diurnal variation in performance, particularly on the rotating activity routine, the only one which permitted testing around the clock. In a general way, the higher the body temperature, the better was the performance. In the operation of the Link Trainer, the higher the total performance scores, the more uniform were the ten successive subscores. This relationship also held for the mean intraperiod and interperiod scores.

- 649 Klinger, E., Gregoire, K. C., & Barta, S. G. Physiological correlates of mental activity: Eye movements, alpha, and heart rate during imagining, suppression, concentration, search, and choice. Psychophysiology, 1973, 10, 471-477.

Measured REMs, EEG alpha, and tonic heart rate (HR) of 21 female undergraduates during 6 types of cognitive tasks--imagining a liked person, suppressing thoughts of the person, searching one's mind for alternative solutions, arithmetic involving little concentration, problems involving high concentration, and choosing a preferred activity. The latter 3 required verbalization; the former 3 did not. Only suppression and search did not differ significantly from each other on at least one physiological variable. Imagining, suppression, and search yielded few REMs, high alpha, and low HR. High concentration yielded many REMs, low alpha, and high HR. Choice yielded many REMs, low alpha, and intermediate HR. Low concentration yielded few REMs, low alpha, and high HR. Suppression produced somewhat less alpha than imagining but did not differ significantly in REMs.

- 650 Klinker, R., Fruhstorfer, H., & Finkenzeller, P. Evoked responses as a function of external and stored information. Electroencephalography and Clinical Neurophysiology, 1968, 25, 119-122.

During the periodic presentation of vibratory stimuli at rates faster than 1 stim/10 sec the amplitude of the cortical evoked response of man decreases as a function of time. If during a fast periodic stimulus sequence single stimuli are irregularly omitted, the omission elicits a cortical response. If identical stimuli are irregularly interpolated in the sequence, their responses are greater than the average responses to the stimuli of the sequence. These facts are a further indication that the amplitude of evoked responses is dependent on, among other parameters, the effective information provided by the stimulus. This effective information might therefore result from a comparison between information concerning stimulus parameters stored by the CNS and the actual incoming events.

- 651 Norman, R. Contingent negative variation and cardiac deceleration in a long preparatory interval: A developmental study. Psychophysiology, 1975, 12, 609-617.

Ten-, 14-, and 19-yr-olds participated in a simple RT task with 5-sec foreperiod. CNV waveforms contained an early and a late negative component, and comparable deceleratory limbs characterized the cardiac waveforms. The 19-yr-olds' early cardiac deceleration underwent intersession habituation and the analogous CNV response intra-session diminution: both processes were absent in younger subjects. Only young adults exhibited steady growth of late cardiac and CNV waves across both sessions. There were no developmental differences in basal body movement or anticipatory slowing of somatic activity or cardiac rate. However, 10-yr-olds had faster basal heart rates and larger acceleratory cardiac responses within the foreperiod than either older group. The results demonstrated partial dissociation of somatic and cardiac activity under the present experimental conditions. The overall results underscore the need for developmental psychophysiological research including childhood and adolescence.

- 682 Klotzbucher, E. Pulsverhalten bei geistiger arbeit in abh ngigkeit von arbeitsdauer und arbeitsintensitat. [The effect of the duration and intensity of mental work on the pulse.] Zeitschrift f r die Gesamte Hygiene und Ihre Grenzgebiete, 1971, 17, 330-332.

The author carried out three experiments with an arithmetic test:

1. For 2 hours, granting a one minute's interval every 10 minutes,
2. For 30 minutes without any interval, under pressure of time,
3. For 2 hours without any interval, under pressure of time.

The correlations between pulse reaction, the arithmetic tasks solved and the number of errors are demonstrated.

- 683 Knott, J. R. Closing overview. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 349-355.

Empirical though we may be, a great many of us are concerned with the "meaning" of the CNV. None of us, in all likelihood, is exempt from having offered some speculation in this area. For some it is "attention". For some others the "attention" is specified as being "selective". "Expectancy" has had its proponents, and many still rally to its banner. Others believe a major correlate to be "motivation." If we wish to regard "the CNV" as the end result of many physiological processes, then there may be multiple psychological, and physiological, correlates, as Hillyard has reminded us in the past. We would do well to avoid becoming locked into--or becoming locked out of--a proposed explanatory channel by virtue of the premature acceptance of any particular hypotheses or concepts. In the course of this Congress we were shown the results of an experiment on CNVs during visual "search and recognition" tasks. Let us, ourselves, continue to search, let us keep on generating CNVs about CNVs, until we reach a supportable set of constructs which give these slow potentials a behavioral role.

- 684 Knott, J. R., & Irwin, D. A. Anxiety, stress and the contingent negative variation. Electroencephalography and Clinical Neurophysiology, 1967, 22, 188. (Abstract)

In a "high stress" situation, 9 subjects with high, and 9 with low, emotionality were similarly tested, except that a strong shock followed either the right or left warning light. A manual response to shock was made only when the warning signal preceding the shock was on the right. The CNVs on non-response trials were the same for both groups, but on the response trials the low emotionality group had higher voltage CNVs.

This seemingly paradoxical finding may be due to a "saturation effect", so that, under stress, anticipatory cortical negativity operates from a higher baseline in the high anxiety (or emotionality) group. In the low anxiety group the response occurs from a lower baseline, and hence does not saturate.

- 055 Knott, J. R., & Peters, J. F. Sex, stress, and interstimulus interval. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 191-193.

The principal findings in this investigation are: (1) CNV behavior can be shown to vary as a function of sex if the experimental conditions are suitably manipulated; and (2) the CNV behavior of females, when placed under stress, is similar to that of anxiety-prone subjects.

- 056 Kogi, K., & Saito, Y. A factor-analytic study of phase discrimination in mental fatigue. Ergonomics, 1971, 14, 119-127.

Attempted to discriminate phases in the course of diurnal variation of cortical functions for 8 operators in a train control center. Critical flicker fusion frequency was measured at different periods of a 24-hr shift. Correlation coefficients among periods were computed and 3 underlying factors were extracted. In accordance with these, the shift periods were classified into the morning-rise phase, the intermediate phase, night-and-early-morning phase, and after-overnight-vigil phase. The last phase, although in the morning hours, did not show the features of the 1st phase, but was characterized by markedly different factors as compared with the early morning. Distribution of observed fusion frequencies was not normal in the phases of night or intermediate factors. Similar factors and phases could be demonstrated also for choice RT. It is concluded that phase discrimination of cortical functions by means of factor analysis would be of use for detecting the overfatigued conditions in operators.

- 057 Kogi, K., & Saito, Y. [Psychophysiological reactions of electric locomotive drivers with or without an assistant driver.] Japanese Journal of Industrial Health, 1971, 13, 89-99.

Eight drivers drove a special train with passengers or freight between Okayama and Hiroshima in the daytime either with an assistant or by experimentally introduced single-driver plan.

1. Average heart rate significantly increased during single-driver driving, as compared with driving with an assistant. The relative increase in beats/min was 2.9 in straight sections and 4.6 in curved and slope sections. The increase was more pronounced in driving situations which demanded increased attention as on down-hill tracks or when nearing the station.

2. Distribution of intervals of saccadic eye movements proved to be a composite Weibull distribution. Percentage of rapid shift of eye movements with intervals of less than 600 msec, which might be indicative of increased caution, was found to increase significantly when advancing through a station yard without an assistant. But this tendency disappeared at the later period on the way back.

3. Factor analysis was conducted on a data matrix of the critical fusion frequency of flicker measured at a total of 52 sessions of two- and single-driver driving. Throughout on- and back-way of two-driver driving one and the same factor was dominant, while single-driver driving was characterized by the alternation of the dominant factors after on-way and the back-way had high weights of a factor associated with periods of declined flicker fusion levels. If eight engineers were divided into two groups according to another factor analysis on subjects by the same data matrix, there was found a group of engineers who showed a distinct decrease of the fusion frequency during the single driving.

- 000 Kogi, K., & Saito, Y. Rhythmic fluctuation of orientation to a continuous manual control task. Journal of Human Ergology, 1973, 2, 169-184.

Fluctuation of orientation to a tracking task was made observable by varying the controlled system characteristics according to the error level of the moment. Male adult subjects performed either compensatory or pursuit tracking for 15 min, and large error increases were seen between intervals of half a minute to a few minutes. Orienting to the task was examined in two ways. In the compensatory tracking, the subject was to find, as quickly as possible, randomly appearing, flickering illumination of the target spot. The critical flicker frequency thus measured was significantly lower during 15-sec periods preceding error increases than during steady control phases, low values from the former periods deviating from a normal distribution. In the pursuit tracking, saccadic eye movements were found less frequently during 15-sec periods prior to large error increases, resulting in lowered instantaneous saccade rates computed from distribution of saccade intervals. These results suggest that a recurrent phase exists in which orienting to the tracking temporarily declines prior to an apparent performance decrement, presumably due to spontaneous lapses of attention.

- 000 Kohlova, J., & Matousek, O. Zmeny vegetativnich funkei pri psychicke einnosti v laboratornich podminkach. [Changes of autonomic functions during mental activity in laboratory conditions.] Ceskoslovenska Psychologie, 1968, 12, 49-62.

The authors try to ascertain: a) what autonomic changes occur during mental activity, b) what is the dependence of these changes on the type and complexity of the task, c) what is the relation of the magnitude of the reaction to the quality and quantity of the performance, d) what influence has the spontaneous and enforced working tempo on the autonomic reaction.

The following tasks were used to model the mental activity in laboratory conditions: Raven's progressive matrices with gradually increasing difficulty of individual tasks with various (i.e. subsequent and random) difficulty of task groups, arithmetic tasks with three degrees of difficulty, acoustic tasks of binary character, signal tasks (reading of light signals on a panel) with different information content and combination of some mentioned tasks. The subjects were men and women 18-35 years of age ($N_1=11$, $N_2=8$, $N_3=14+7$). Changes (which occur during work on a mental task) in pulse frequency, in breathing and in the skin response (measured by deceptograph) correlate significantly ($R = 0.783$ to 0.933). Therefore merely the pulse frequency taken telemetrically in further experimental series was used. The most significant changes in pulse frequency occur immediately at the beginning of the activity; when the spontaneous tempo continues the autonomic reaction decreases, even when the task becomes more difficult. If the working tempo is enforced the pulse frequency commensurably increases depending on the increasing complexity of the task up to the moment when the requirements of the task pass the immediate performance capacity. The passing of this performance capacity weakens the motivation of the subjects (pending the current knowledge of the results) and the pulse frequency declines. The non-working values of the pulse frequency (measured in brief intermissions between the individual tasks) in adjusted subjects hardly change in the course of the whole experiment (about 3 hours); unadjusted subjects, show first increased nonworking values and later the values decrease, until they reach the level of adjusted subjects.

- 680 Kohlova, J. & Matousek, O. Ein beitrag zur bewertung der psychischen belastung von operatoren in modellsituationen. [Contribution to the evaluation of mental load of operators in model situations.] Proceedings of a Symposium on Ergonomics in Machine Design jointly organized by the Czechoslovak Medical Society J. E. Purkyne and ILO, Prague, 2-7 October 1967, ILO, Geneva, 1969, 1, 109-115.

Possibilities of the evaluation of mental load were studied on a control-desk model which permits display of variously coded information. Two methods were used: double tasks and measurement of changes of some autonomic functions. Some psychological tests, tasks of calculation, visual and auditory tasks were used as primary and secondary tasks imposing varied degrees of stress. Among autonomic functions, heart rate, respiration rate and skin resistance were measured. From the practical point of view, acoustic tasks and pulse rate were considered most useful. When determining mental load, precise mathematical description of the performance is essential, and the factors of motivation must be respected.

- 681 Kohn, M., & Lifshitz, K. A nonparametric statistical evaluation of changes in evoked potentials to different stimuli. Psychophysiology, 1976, 13, 392-398.

An experiment yielding the evoked electroencephalographic potentials (EPs) to seven different stimuli was conducted on a population of 13 female and 7 male normal subjects. Patterned-visual, auditory and combined (bimodal) stimuli were used. One stimulus case required subject responses. Calculations of the first four statistical sample moments at the EP time points indicated nongaussian amplitude distributions. A nonparametric statistical test, the Mann-Whitney U-test, was used to detect the significant point by point ($p \leq .01$) differences among the EPs to the visual, auditory and bimodal stimuli. The most extensive differences were obtained from EPs to stimulus pairs requiring subject response (identification). Differences among the EPs to different visual patterns existed to a lesser extent than to stimuli of different sensory modalities. In general, a change in the physical parameter of the stimulus induced changes in the earlier components, while the response requirement induced changes in the late components of the EP. No significant differences were found in EPs to the same stimuli between recording locations with hemispheric symmetry.

- 682 Kok, A. The influence of speed and interval variation of serial stimuli on physiological change. Acta Psychologica, 1970, 34, 22-38.

Studied changes in heart rate (HR), heart rate variability (HRV), blood volume pulse (BVP), respiration speed (RS), and alpha rhythm (AR) under conditions of the variation of the speed and intervals of auditory stimuli in a serial 2-choice response task. The analysis of variance of the percentage scores revealed that the differences between the 3 speed levels, the 5 physiological variables, and also the 2nd-order interaction between the speed of presentation and the physiological variables were significant. The difference between the interval variation levels was not significant. The short-term effect of step-wise variation of the duration of intervals between successive stimuli on physiological change was also investigated and an explorative study was made of the periodic fluctuations of 3 physiological variables by applying the techniques of auto-correlation and power spectrum analysis.

- 663 Kok, A. Individual differences in heart rate and skin resistance during information processing. Nederlands Tijdschrift voor de Psychologie en haar Grensgebieden, 1975, 30, 255-275.

Investigated individual differences in heart rate and skin resistance among 50 male Ss while performing 2 information processing tasks with regard to the personality variables of neuroticism and extraversion. The tasks were (a) pressing different buttons in response to high and low tones and (b) mentally adding certain digits to other digits previously given. Results of the 1st task indicate that the physiological dimensions of variables with average levels of stimulation, size of tonic response, and amount of spontaneous variability were strongly interrelated, but the relationship of these dimensions to the number of errors and to neuroticism and extraversion was slight. No clear relationship was found between the 2nd task and personality variables. The study refutes the intake-rejection hypothesis formulated by J. I. and B. C. Lacey.

- 664 Kok, A. The effect of S2 intensity and eye fixation on the EEG in a preparatory interval. Psychophysiology, 1977, 14, 101. (Abstract)

Alpha Rhythm (AR), Contingent Negative Variation (CNV), and Heart Rate (HR) were recorded from 12 subjects during performance of a simple visual reaction time task. The warning stimulus (S1) lasted 4 sec. In the task conditions the imperative stimulus (S2) was a change in intensity of S1 that could either be small or large. In the control condition only the S1 was presented, and no response was required. Ocular fixation was manipulated by presenting the subject either a homogeneous visual field (a Ganzfeld) or by projecting a small fixation target in the center of the field. The results lead to the following conclusions: 1) Fixation of a target causes a significant desynchronization of AR in the preparatory interval, compared with conditions during which no fixation occurs. 2) The effect of ocular fixation on alpha desynchronization is more prominent than the effect of intensity of S2. 3) The response curves of control and task conditions show a great discrepancy with respect to the HR and CNV, whereas this discrepancy is absent for the AR.

It is suggested that, as opposed to the HR and CNV, alpha blocking is not a sensitive indicator of a preparatory process insofar as it relates to an imperative stimulus followed by a motor response.

- 665 Kooi, K. A., & Bagchi, B. K. Visual evoked responses in man: Normative data. Annals of the New York Academy of Sciences, 1964, 112, 254-269.

Normative values for amplitudes and latencies of major components of the averaged visual evoked response, obtained from examination of 100 medically screened adults, have been presented for three cerebral regions. Complexity of configuration, regional differences, and intra-individual consistency have been emphasized.

Because of the importance of procedural constants and electrode arrangement in determining the recorded response form, wave identification is in its preliminary stage. The following description and numerical designations apply to scalp-ear or scalp-cervical recordings with methodological variables as outlined. The peak of the initial occipital surface negative wave (I) generally fell within 30-42.5 msec following the flash. In the parietal region, the initial peak negative deflection tended to be 5-10 msec later. Wave I appeared to be composed of two or more rapid deflections, its peak amplitude-latency histogram being multiphasic and skewed to the side of longer latency. In about one-half of the subjects, a surface positive wave, which reached its maximum amplitude between 20-30 msec, could be identified preceding Wave I. Wave II, surface positive, culminated between 60-80 msec. Wave III (occipito-parietal wave), surface

negative, most commonly attained its peak amplitude between 80-120 msec. Waves IV, surface positive, and V (vertex sharp wave), surface negative, fell within the 90-120 and 120-170 msec ranges respectively. Waves I and II were usually of greater amplitude over the parietal region while wave III was higher over the occipital area. Waves IV and V were maximal over the central region.

- 666 Kornhuber, H. H., Becker, W., Taumser, R., Hoehne, O., & Iwase, K. Cerebral potentials accompanying voluntary movements in man: Readiness potential and reafferent potentials. Electroencephalography and Clinical Neurophysiology, 1969, 26, 439. (Abstract)

With the exception of this last part, the readiness potential seems to be related only indirectly to the motor process, for it shows rather different amplitudes during the same movements. It is, however, correlated with the subjects interest and involvement in the experiment. In conditioning experiments there is a similar slow surface negative potential between the conditioning and indicative stimuli. This is accompanied by decrease of motor reaction time (Walter, Arch. Psychiat. Nervenkr., 1964, 206: 309). This too indicates a facilitating process in the cortex.

Recently we have investigated the cerebral potentials during voluntary eye movements in man. The eye artefact can be eliminated by summation of the potentials with right and left gaze. The readiness potential, including the potential shortly before and after onset of the saccadic eye movement, is larger in the precentral than in the occipital region. This is compatible with the hypothesis that the command for saccadic eye movement is given by the frontal eye field.

- 667 Kornhuber, H. H., & Deecke, L. Hirnpotentialänderungen bei Willkurbewegungen und passiven Bewegungen des Menschen: Bereitschafts potential und reafferente Potentiale. [Changes in human brain potentials following voluntary as well as passive movements: Readiness and afferent potentials.] Pflügers Archiv fuer die Gesamte Physiologie des Menschen und der Tiere, 1965, 284, 1-17.

A method of chronological data storage and reverse computation is described by which bio-electrical phenomena preceding 'spontaneous' events within the nervous system can be analysed if these events appear repeatedly and are capable of triggering a computer.

Slow brain potentials accompanying voluntary and passive movements of the limbs were analysed by this method. These potentials were recorded from different points of the scalp from 12 healthy subjects in 94 experiments with more than 100 movements in each record. At times artifacts were superimposed upon cerebral potentials. The former were identified, and, as far as was possible, eliminated.

Voluntary hand or foot movements are preceded by a slowly increasing surface-negative cortical potential of 10-15 μ V, called readiness potential. This potential is maximal over the contralateral precentral region, but shows bilateral spread and is larger over the frontal than over the occipital areas. The readiness potential increases with intentional engagement and is reduced by mental indifference of the subject.

Voluntary movements are followed by a complex potential with an early positive phase that begins 30-90 msec after the onset of movement. The late potentials following voluntary movements are similar to those after passive movements. Both resemble the late bilateral components of the evoked potentials after electrical stimulation of peripheral nerves. Some variable differences between the early components of the potentials after the onset of active and passive movements require further investigation.

No relation between the onset of voluntary movements and the phase of the alpha rhythm could be detected.

- 666 Korzh, N. N., Sokolov, E. N., & Cole, M. L. K mekhanizmu obnaruzheniya zvukovykh signalov chelovekom. [The mechanism of detection of auditory signals in man.] Voprosy Psikhologii, 1969, 15, 126-131.

EEG and EMG recordings were obtained from Ss instructed to make a fist when they heard a tone. Both latencies and trace motor responses increased with decreasing signal intensity and were linearly correlated. Increased latencies and trace motor responses correspond to a decrease in the probability of hits. Responses in the form of alpha-blocking extinguish in the presence of suprathreshold stimuli; they are relatively more permanent when stimuli are weak. As a result the length of the trace motor response and the probability of EEG response increase with decreasing signal intensity. To explain these results it is necessary to assume that the mechanism for detecting signals against a background of noise exists in 2 independent systems, an on and an off system.

- 669 Koster, W. G., & Taverne, G. La mesure de la charge perceptive: Comparaison de quelques methodes. [Measurement of perceptual load: Comparison of different methods.] Actes du Troisieme Congres de la Societe d'Ergonomie de Langue Francaise, Bruxelles: Presses Universitaires de Bruxelles, 1968, 343-351.

Sinus arrhythmia was one of the methods evaluated. It was found to have a poor correlation with subjective impressions; a mediocre capability of distinguishing task from resting conditions and very good capability in distinguishing between tasks.

- 670 Koukkou, M., Madey, J. M., & Yeager, C. L. Memory and vigilance: Spectral EEG analysis during learning in humans. Electroencephalography and Clinical Neurophysiology, 1969, 27, 687. (Abstract)

EEG spectra obtained during learning of new sentences were compared with spectra during relearning of sentences which were familiar to the subjects. Within the same class of recall, distinctly higher levels of vigilance were associated with learning of unfamiliar material than with relearning of familiar material.

Our results demonstrate a systematic relation between the level of vigilance (objectively assessed by computer analysis of the EEG) during learning and the quality of the memory storage.

- 671 Kozarovitskii, L. B. Dinamika Kozhno-Gal' Vanicheskikh Reaktsii U Dispatcherov V Usloviakh Napriazhennoi Raboty za Pul' Tom Upravleniia Dvizheniem Samoletov. [Dynamics of skin-galvanic reactions in control panel operators during their work of regulating airplane traffic.] Zhurnal Vysshei Nervnoi Deiatel' nosti, 1964, 14, 387-396.

In inexperienced airline dispatchers the galvanic skin responses deviated from normal due to fatigue at the end of a working day or under tension. The character of tracing showed diminishing skin resistance, either an increase or a decrease in amplitude in different individuals, and a decrease in frequency. Distraction of attention tended to lower the skin resistance which depends on stimulating and suppressing processes. Experienced subjects showed fewer sharp variations, less fluctuation in amplitude, a faster fading of the response and less reaction to the extraneous stimuli.

- 672 Krause-Liebscher, I., & Krause, R. Über den biorhythmus des sehorganes. [The biorhythm of the visual organ.] Zeitschrift für Ärztliche Fortbildung, 1965, 59, 96-106.

A study was made of the functions of the visual organ over a 24-hour period, to explain some occupational physiological problems and study the problems encountered in shift workers. Studies and measurements in several subjects confirmed the assumption that there is a biological rhythm of physiological performance and fatigue processes for certain visual functions.

- 673 Kreitman, N., & Shaw, J. C. Experimental enhancement of alpha activity. Electroencephalography and Clinical Neurophysiology, 1965, 18, 147-155.

1. A cross-over randomised latin-square design was used to test eight normal subjects for their EEG responses to auditory, tactile and visual discrimination tasks, and to mental arithmetic.

2. Enhanced alpha activity occurred in 24 out of 64 test occasions. There were significant differences between subjects' mean alpha responses; enhanced responses occurred at least once in seven of the eight subjects. There were also significant differences between tests, tactile testing being most often associated with enhanced responses and visual tests least often.

3. No association was found between the type of resting EEG and alpha change scores on testing.

4. Arousal, as defined by EMG criteria, was positively correlated with degree of blocking, but the association was too weak to account for the differences in alpha activity between individuals or between tests.

5. Two patterns of "adaptation" during testing are described. During the period of stimulation (2 min) blocking responses showed a gradual return towards the resting level, while enhancement responses showed a continuous rise.

6. The role of visual activity, including imagery, is thought to be an unlikely explanation of our results. Alpha activity probably has more than a single determinant. Theories of alpha activities which fail to account for enhancement effects must be reformulated, and in this context the study of adaptation patterns to constant stimuli might prove rewarding.

- 674 Krinchik, E. P. O determinatsii povedeniya veroyatnostnoi strukturoi situatsii. [How behavior is determined by the probability structure of the situation.] Voprosy Psikhologii, 1968, 14, 24-35.

EMG recordings were taken from the fingers of Ss instructed to press a key with 1 hand at the presentation of a low tone and press with the other hand when a high tone was sounded. The probabilities of stimulus presentation were 1, .93, .5, and .07. The muscle tension patterns were found to be determined by the probability structure of the task; however, these patterns developed gradually in the course of the experiment, suggesting that attention-directing and preparatory muscle tensions reflect the efferent control of behavior by subjective probability models.

- 676 Krivohlavy, J. Fyziologicke korelaty informacniho vykonu. [Physiological correlates of informational performance.] Activitas Nervosa Superior, 1968, 10, 165-171.

The relationship between heart and respiratory rate, pulse regularity, depth of inspiration, and the amount of presented information was studied in 22 Ss under 2 conditions: The amount of presented information equated either 3/4 (underload) or 5/4 (overload) of the individual's capacity. Ss with lower heart rate and low error number during underload performance showed an increase in heart rate during the overload performance. Ss with higher heart rate and error number during the underload condition showed the opposite tendency. The pulse irregularity increased with the amount of information only in mental, but not in verbal reproduction. Attitude was important as regulator of physiological functions reflected by the changes in the level of mental activation which is only partially determined by the presented or processed information.

- 676 Krivohlavy, J. Tepova frekvence a informacni zatezovani pri psani strojem. [Pulse rate and the information load during typing.] Activitas Nervosa Superior, 1968, 10, 172-176.

The conclusion of G. Gancev et al. from 1967 was checked. He asserted that the pulse rate can be used as an objective criterion of the degree of tension of higher nervous centres. Experiments of Gancev et al. were repeated but the results obtained did not confirm this statement. The significance of differences appears to be problematic. These doubts are based on results of other experiments with increasing the input of the flow of information. Even if it is not possible to derive from the lack of significance the non-existence of the relationship, the results would suggest caution. Doubtful is also the a priori identification 'of the degree of tension of higher nervous centres' with 'the magnitude of the required information performance' as stated in the work of Bulgarian authors.

- 677 Krkovic, A., & Borkal, Z. Utjecaj poloza tijela motrioca na detektiranje rijetkih signala i na elektroencefalogram. [Vigilance performance, electroencephalogram, and posture of the human monitor.] Revija za Psihologiju, 1970, 1, 15-18.

Investigated the efficiency of detecting rare auditory signals (2 equally long sequences of beats) using 12 Ss under conditions of lying, sitting, and standing. EEG activity and number of detections in different phases of monitoring were registered. No significant differences in detections were found in different postures. EEG activity was markedly different in standing from the EEG activity in the other 2 postures. These results are contrary to the expectations which could be derived from activation theory of vigilance.

- 678 Krupski, A. Heart rate changes during a fixed reaction time task in normal and retarded adult males. Psychophysiology, 1975, 12, 262-267.

The relationship between heart rate (HR) changes and fixed reaction time (RT) performance was studied in groups of normal and mentally retarded male Ss. Each S received blocks of 15 RT trials during 4-, 7-, and 13-sec preparatory intervals. Heart rate was continuously monitored. The results revealed that retarded Ss had significantly slower RT scores, significantly lower basal HR, and lower magnitude HR decelerations prior to reaction signal onset when compared to normal Ss. These group differences were apparent in all three preparatory interval conditions and were interpreted to indicate less accurate covert timing of PI length in retarded Ss. Correlations between HR deceleration (measured during the sec in which the reaction signal occurred) and RT scores lent support to the notion that significant HR deceleration accompanies fast RT responding in all but the 13-sec PI condition for retarded Ss. In this condition, HR acceleration was related to fast RT performance in retarded Ss. It was suggested that in the 13-sec PI, retarded Ss exhibited a dissociation between somatic and autonomic response systems which might be related to an information processing deficit in tasks of extended duration.

- 679 Krupski, A., & Fitzgerald, H. E. Heart rate concomitants of attention in normals and retardates during a reaction time task. Psychophysiology, 1971, 8, 269-270. (Abstract)

The HP analysis revealed significant group differences in sec-by-sec HP responding. A dramatic difference in HR deceleration at about the time the response signal was to occur was found between retarded and normal groups. In all three PI conditions, normals showed a significant deceleration which reached its nadir just prior to or at the time the response signal was to occur, while retardates showed either an absence or severely attenuated HR deceleration at this point.

Such data would seem to demonstrate the retardate's inability to prepare for appropriate responding regardless of the length of the preparation time. If one accepts the assumption that HR measures during the PI reflect an attention process, the data clearly support the idea that the retardate suffers from an attention deficit. Although this notion is not a novel one in retardation research, very few "hard" data exist to support it. Thus, this study points out the value of using psychophysiological techniques for understanding mental retardation. Perhaps these techniques provide a much needed window for viewing retardate behavior.

- 680 Krupski, A., Raskin, D. C., & Bakan, P. Physiological and personality correlates of commission errors in an auditory vigilance task. Psychophysiology, 1971, 8, 304-311.

To determine correlates of the tendency to make errors of commission in a vigilance task, 31 male undergraduates worked at a task of listening to recorded digits for 48 min and reported odd-even-odd digit sequences. Reports of "signals" where signals did not actually occur constituted commission errors. While S was engaged in the vigilance task skin conductance was continuously recorded. A measure of extroversion and neuroticism was available for each S. The tendency to make commission errors was associated with decrement in the detection of real signals over time, low GSR amplitude at detection points, and low initial orienting response. Commission errors were positively related to extroversion and unrelated to neuroticism. It is concluded that commission errors are made by Ss who are low in arousal level, subject to vigilance decrement, and likely to score higher on extroversion.

- 681 Kudinov, M. P., & Myslobodskii, M. S. O zavisimosti parametrov vyzvannogo potentsiala mozga cheloveka ot sostoyaniya vnimaniya. [On parameters of evoked potential of the human brain as a function of state of attention.] Zhurnal Vysshei Nervnoi Deyatel' nosti, 1968, 18, 1027-1034.

Nineteen 18-30 yr old Ss were employed to study the changes in average evoked potential of the visual cortex in response to light as functions of sleep, the quiet waking state, and attraction and distraction of attention. Average evoked potential in response to light in the quiet waking state consisted of several positive-negative oscillations, followed by an afterdischarge with alpha-rhythm frequency. Sleep increased the amplitude and duration of the average evoked potential, primarily due to the 2nd, 3rd, and 4th positive waves, with replacement of the sensory afterdischarge by a slow negative wave. Attraction and distraction of attention changed the amplitude of individual waves of the average evoked potential in the different directions, whereas its temporal characteristics remained usually closely connected with the motor reaction regardless of direction of attention.

- 682 Kutas, M., McCarthy, G., & Donchin, E. Measuring ERP amplitudes despite latency jitter. Psychophysiology, 1977, 14, 95. (Abstract)

Signal averaging enhances the amplitude of signals which are time-locked to the synchronizing event. The technique will therefore underestimate the amplitude of event-related potentials (ERP) whose latency varies with respect to the eliciting stimulus. This fundamental feature of signal averaging makes it sometimes difficult to interpret amplitude changes in the ERP. Similar changes might be caused either by actual changes in the amplitude of the potentials associated with the individual stimuli or by increases, or decreases, in the latency jitter of the potentials.

Woody (1967) proposed a technique which augments signal averaging through an estimate of the latency jitter. We report an application of Woody's technique to ERPs associated with different semantic categorizations.

Subjects were presented with series of words with each series containing words from two categories. Words from one category appeared only 20% of the time according to a random schedule. Subjects either counted the rare words, performed a choice RT task in which accuracy was emphasized, or a choice RT task in which speed was emphasized. The difficulty of the categorization required varied between series. Kutas and Donchin (1976) reported that the latency of P300 increased with the complexity of the categorization. Amplitudes of P300 also varied but could not be interpreted. Employing Woody's technique (cross correlating each trial record and then time-locking to point of maximal cross correlation), we obtained a measure of the temporal jitter demonstrating an increase in jitter with complexity of processing. Furthermore, amplitude measures which can be interpreted were obtained. The implications of the results will be discussed.

683 Kveim, K. B. Muscular and circulatory responses: Their sensitivity assessed in a signal detection situation (Doctoral dissertation, Indiana University, 1966). Dissertation Abstracts, 1967, 27, 2527B. (University Microfilms No. 66-14, 848)

In this attempt to employ detection methodology in the assessment of the absolute sensitivity of somatic response systems, four muscular and four circulatory variables were studied: EMG potentials from the forearms, neck, and jaw; amplitude of R-wave in EKG, heart cycle time, digital volume pulse, and finger volume.

The somatic responses were recorded continuously while four subjects engaged in a typical auditory detection task. During 0.25-sec observation intervals (trials), occurring every 15 seconds, a 1000-cps signal was randomly added on half of the trials to a continuous white-noise background. After each trial the subject made a decision whether the observation interval was more likely to have contained noise alone (N) or noise plus signal (S), indicating his decision on a four-category rating scale. A total of 800 trials per subject was presented in the course of four sessions, two sessions conducted with a signal-to-noise ratio of 31.6 and two with a ratio of 15.8 (these levels of relative signal energy are so low that the subject never can be very sure any signal has been presented). The somatic activity was assessed both before and after each observation interval; readings of the integrated EMG potentials were obtained for each of four seconds, while the circulatory variables were measured on each of 15 heart beats.

When the activity on S and N trials was compared, reliable "signal effects" were found in all of the variables. When the signal effects produced by the two energies were compared, reliable differences were established for all but two EMG variables.

Depending on the variable, the effects had short or long latency and lasted briefly or for several seconds. The effects could often be brought out in a systematic manner by simple measures of absolute level of somatic activity at specific points, but frequently these small detection reactions were expressed more consistently (within or across subjects) by measures utilizing information from two or more points.

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- 684 Lacey, B. C., & Lacey, J. I. Studies of heart rate and other bodily processes in sensorimotor behavior. In P. A. Obrist, A. H. Black, J. Brener & L. V. Di Cara (Eds.), Cardiovascular psychophysiology: Current issues in response mechanisms, biofeedback, and methodology. Chicago: Aldine, 1974.

Those experiments which had in common a major requirement for sustained attention to external stimuli provide evidence that a majority of individuals show cardiac deceleration while performing such tasks. The experiment on Tone Detection, provided evidence that the response is an individually reliable one, over four separate sessions. This same experiment also demonstrated intrastimulus stereotypy, since reliable cardiac acceleration was found in a small subset of subjects. Further experimentation will be necessary to better understand these atypical responses. It is possible that undefined responses to undefined parameters of the particular situation overwhelmed and masked a usual tendency to decelerate while noting and detecting environmental events. One must inquire, however, whether such individuals characteristically fail to show a decelerative response under more benign conditions requiring environmental intake.

- 685 Lacey, J. I. Psychophysiological approaches to the evaluation of psychotherapeutic process and outcome. In E. A. Rubinstein & M. B. Parloff (Eds.), Research in psychotherapy (Vol. 1). Washington, D. C.: American Psychological Association, 1959.

This article reviews the literature that relates psychophysiological changes to such variables as: conflict, threat, frustration, anxiety, anger, fear, startle, pain, embarrassment, and attention. As a result of the review the following recommendations are made concerning the use of autonomic measures as indicator functions: (1) Clear distinctions should be made among three dimensions of autonomic activity, namely, tension, lability, and spontaneous activity; (2) Appropriate and defensible mathematical techniques must be used in arriving at measures of lability. Simple difference or percentage measure of change are rarely, if ever, defensible. This topic has been touched upon only lightly in this paper. It is discussed in detail elsewhere. (3) One measure of somatic "arousal" cannot serve as an index to the state of other measures. Even at best, the intercorrelations among autonomic measures is low. (4) So far as present evidence goes, individual indicant concordance is so low that single autonomic measures cannot be used to unequivocally rank-order the "arousal-value" of different stimuli for a given individual, or the "arousability" of different individuals.

- 686 Lacey, J. I. Somatic response patterning and stress: Some revisions of activation theory. In M. H. Appley & R. Trumbull (Eds.), Psychological stress: Issues in research. New York: Appleton-Century-Crofts, 1967.

The general conclusions to be drawn can be stated briefly. There is strong neurophysiological and psychophysiological evidence that different fractions of autonomic, electroencephalographic, and motor response are mediated separately, by perhaps "intimately related" but clearly dissociable mechanisms. The dissociation may be biologically useful because the different fractions of response can influence cortical and subcortical functioning in different, and sometimes opposing, ways. While we have not yet really demonstrated that the neurophysiological mechanisms I have discussed account for the observed psychophysiological correlations, the parallels are suggestive. In chronic animals at least, direct tests may be possible of the hypothesis that the visceral afferent negative feedback from heart to brain is in fact operative during attentive observation of the environment, in the ways outlined above, and does in fact account for the observed relationships. Whether observations such as these have implications for the study of physiological response to "stress" will be left for the reader to decide.

- 687 Lacey, J. Autonomic indices of attention, readiness, and rejection of the external environment. In D. P. Kimble (Ed.), Readiness to remember: Proceedings of the third conference on learning, remembering and forgetting. New York: Gordon and Breach, 1969.

In this report, Lacey presents data that call into question the generality of activation and arousal theory. In addition, data are presented that indicate that cardiac deceleration is related to stimulus intake and that cardiac acceleration is related to rejection of the external environment.

- 688 Lacey, J. I. Some cardiovascular correlates of sensorimotor behavior: Examples of visceral afferent feedback. In C. H. Hockman (Ed.), Limbic system mechanisms and autonomic function. Springfield, Ill.: Thomas, 1972.

Is the impact of the environment on the autonomic functions of the organism really as diffuse as traditional doctrine would suggest? The opinion was advanced repeatedly in this symposium that it could not possibly be and that there had to be much more delicate modulation of the effects of internal and external events on autonomic functions. I agree with this opinion, and I plan to present experimental data demonstrating that autonomic effectors show different patterns of activity during different kinds of [attentional demands]. I will come to focus on differential responses of heart rate and blood pressure, and I will offer, as a provocative working hypothesis, the notion that explanations for the data are to be found in the mechanisms of feedback from the cardiovascular system that Dr. Dell and Dr. Hockman talked about in previous chapters.

- 689 Lacey, J., Kagan, J., Lacey, B. C., & Moss, H. A. The visceral level: Situational determinants and behavioral correlates of autonomic response patterns. In P. K. Knapp (Ed.), Expressions of the emotions in man. New York: International Universities Press, 1963.

The studies discussed in this article deal with physiological correlates of situations in which S is assumed to want to accept the external environment, reject the external environment, as well as situations in which subject involvement is assumed to have played a crucial role.

- 690 Lacey, J. I., & Lacey, B. C. The relationship of resting autonomic activity to motor impulsivity. In The brain and human behavior. Association for Research in Nervous and Mental Disease. Vol. 36. Baltimore: Williams & Wilkins, 1958.

It was established that the rate of emission of autonomic fluctuations, as seen in recordings of skin resistance and heart rate, was a reliable individual characteristic. The resting rate tended to be fixed in magnitude upon 18-hour re-test. An heuristic interpretation was made that these fluctuations were spontaneous rather than stimulus-evoked, and served as "energizers" of cortical mechanisms. A review of the relevant neurophysiological literature led to the construction of a physiological model that related frequency of autonomic fluctuation, but not level of autonomic function, to hyperkinetic-impulsive aspects of behavior. This retrospectively accorded with observed personality differences between extreme individuals who were characterized by very low or very high frequencies of autonomic discharge. A separate experiment confirmed the theory in most details. Resting rates of autonomic fluctuations were significantly related in predicted directions to (a) the frequency of occurrence of erroneous and impulsive motor responses, (b) reaction times, (c) the temporal course of the development and maintenance of a set to execute a specific motor response, and (d) the ability to voluntarily increase response latencies. Autonomic level related only to (c). A major contradiction between theoretical prediction and empirical fact occurred in that rates of fluctuation, as measured, during the performance of the task did not relate to psychomotor variables. This was attributed to two artifacts of measurement. Our technique of measurement (the number of 30-second intervals, in a 15-minute rest period, in which autonomic variation was seen) was relatively crude and failed to adequately reflect the periods between bursts of autonomic activity. Moreover, theoretical considerations suggest that the following variables need to be taken into account: the number of cycles in a chained series of autonomic responses, and rate of evolution of single autonomic bursts. These conclusions follow from a consideration of the role of autonomic discharge, particularly cardiovascular discharge, as a stimulus to the baroreceptors of the carotid sinus and aortic arch, which are structures essential to the mechanisms hypothesized to account for the predicted and empirically established co-variation between hyperkinesis and impulsivity, on the one hand, and frequency of autonomic fluctuation, on the other hand.

- 691 Lacey, J. I., & Lacey, B. C. Some autonomic-central nervous system interrelationships. In P. Black (Ed), Physiological correlates of emotion. New York and London: Academic Press, 1970.

Two initial steps seemed to us to be required. We first had to specify, if we could, experimental conditions that reliably would produce, not the familiar elevations of heart rate and blood pressure, but decreases in these variables, while other physiological variables simultaneously were showing sympathetic-like changes. We then had to demonstrate, if we could, that acutely produced decreases in cardiovascular activity were correlated with increased behavioral efficiency, a result that would be contrary to current views. Ultimately, of course, we would need to show that these facts - if they could be demonstrated in intact human organisms--truly could be explained by the operation of the negative feedback path from the heart to the brain.

We have had some success in taking the first two steps. The rest of this paper will be devoted to a brief review of the evidence that leads us to suggest that one important effect of cardiovascular activity on behavior is to gate environmental inputs and motor outputs into and out of the CNS; that elevations in blood pressure and heart rate may produce, under appropriate circumstances, a sort of "stimulus barrier" (to use a picturesque term from psychoanalysis) and that decreases in heart rate and blood pressure may produce a more permeable "stimulus barrier."

- 692 Lacey, J. I., & Lacey, B. C. Experimental association and dissociation of phasic bradycardia and vertex-negative waves: A psychophysiological study of attention and response-intention. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 281-285.

The heart then decelerated as a correlate both of attention and response-intention. The simultaneously recorded CNV response, however, indexed only response-intention.

On the other hand, the vertex potential responded to the expected immediacy of reinforcement because it was greater ($P < 0.01$) on block administrations of trials with immediate reinforcement than on block administrations of trials with delayed reinforcement. On random schedules, as a control, CNVs were equal. The heart rate did not show this effect of favoring immediate gratification.

The SP recordings show what is, so far as we know, a new electro-dermal phenomenon. Instead of large biphasic deflections, we observed a slow and small increase in palmar positivity, $P < 0.01$ in all 4 subgroupings.

- 693 Lacey, J. I., & Lacey, B. C. On heart rate responses and behavior: A reply to Elliott. Journal of Personality & Social Psychology, 1974, 30, 1-18.

Replies to R. Elliott's recent critical review of J. I. Lacey and B. C. Lacey's position concerning the relationship of cardiovascular activity to behavior. It is claimed (a) that Elliott misinterprets the Laceys' psychophysiological and neurophysiological hypotheses, (b) that he has been selective and insufficiently critical in his citation of the research by other investigators, and (c) that the "alternative" position which he finds acceptable is not truly contradictory and is neither based on adequate data nor free from technical and conceptual difficulties. [Article also reviews the relationship between heart-rate and attention.]

- 694 Lang, P. J., Gatchel, R. J., & Simons, R. F. Electro-cortical and cardiac rate correlates of psychophysical judgment. Psychophysiology, 1975, 12, 649-655.

Nine undergraduate volunteers participated in a frequency discrimination task. They were asked to rank five different pure tones, presented individually, and report their judgment several seconds after each tone terminated. Tones generally ranked correctly in frequency yielded larger fast-cortical potentials and evoked heart rate responses. Stimuli which occasioned frequent errors prompted a specific, negative, slow cortical wave, which could be distinguished both from eye movement artifact, and the slow wave changes associated with orienting and anticipation. The physiological data were analyzed in terms of two conceptions of the cognitive processing involved in psychophysical judgments.

- 695 Lansing, R. W., Schwartz, E., & Lindsley, D. B. Reaction time and EEG activation under alerted and nonalerted conditions. Journal of Experimental Psychology, 1959, 58, 1-7.

Reaction time means and SD's did not differ for the three nonalert conditions, but were markedly reduced when the warning signal produced alpha blocking prior to the visual reaction stimulus. The reduction in RT as a function of the length of the foreperiod interval followed precisely the same time course as the curve showing the degree of alpha blocking as a function of the foreperiod interval. The RT's vary with duration of foreperiod alerting, attaining minimal levels by 300 msec. Since alpha blockade or EEG activation typically occurs within this same interval, both reduced RT and activation are believed to be identified with an alerted or attentive state produced through action of the ascending reticular activating system (ARAS) resulting from sensory stimulation and instructional set.

- 696 Larsen, L. E., & Walter, D. O. On automatic methods of sleep staging by EEG spectra. Electroencephalography and Clinical Neurophysiology, 1970, 28, 459-467.

This research grew out of a comparison of the multiple regression (MR) technique for sleep stages classification and the technique of multiple discriminant (MD) analysis as previously used by this laboratory.

A prominent source of error in both techniques resided in the difficulty of identifying low-alpha subjects in stage 1 sleep and high-alpha subjects in REM. These findings prompted a systematic study of whether high- and low-alpha subjects, as identified by the waking records, differ in other stages of consciousness. We found that high- and low-alpha subjects were easily discriminated in all stages studied except REM, where only one record was misclassified from each group.

Many techniques were investigated subsequently for their ability to improve the operation of the MD method. The combination of a layered decision process that is based on the identification of "clumps" in the test space and the use of smoothly curved decision boundaries (i.e., quadratic discriminant functions) raised the level of performance on the testing data sample to the following levels of percent agreement with clinical classification: waking, 91%; stage 1, 64%; REM, 66%; stage 2, 85%; stage 3, 85%; and stage 4, 85%.

We conclude that spectra are adequate measurement parameters for all sleep stages with the possible exception of the stage 1/REM discrimination, where the level of performance is marginally acceptable.

- 007 Lassman, F. M., & Seewald, R. C. Effects of attention state and intensity level on human auditory evoked (averaged) cardiovascular response. Journal of the Acoustical Society of America, 1974, 56, S63. (Abstract)

Effects of varying listening postures and different intensity levels on averaged cardiovascular responses to acoustic signals were studied. Twenty-four normal-hearing female volunteers were offered five 1000-Hz tones (800-msec duration, 10-msec rise/decay), one signal each 45 seconds. EKG activity was recorded by a Medtronic Tachograph and then "averaged" through a Fabri-Tek FT 1052. Half the subjects received a 30-dB-SL signal first, the other half a 70-dB-SL signal first. Within a month, the experiment was repeated with the other sensation level, i.e., 70 dB SL or 30 dB SL, respectively. Listening conditions included: counting, reading, repose, and a nonstimulus control. Listening order was balanced. For all listening and intensity conditions, a multiphasic response pattern of initial deceleration, followed by acceleration, a second deceleration, and a long return to baseline was usually observed. At 70 dB SL, response patterns appeared uniform regardless of listening state. But at 30 dB, counting showed a significantly larger change than reading and heart rate took longer to return to baseline at all listening conditions. Counting appeared to maximize the response to the 30-dB signal.

- 008 Laurell, H., & Lisper, H. O. Changes in subsidiary reaction time and heart-rate during car driving, passenger travel and stationary conditions. Ergonomics, 1976, 19, 149-156.

A reaction time (RT) task was used in three conditions, each lasting 2 h, during which six female subjects: (i) drove on a 5 km closed track, (ii) were driven as passenger on the same track, and (iii) were tested in a stationary vehicle. There was an increase in RT only in the driving condition. Furthermore, there was a progressively greater increase in RT over the three successive test sessions, independent of the order in which conditions were tested. Measurement of heart rate (HR) showed that HR decreased only in the driving and the passenger conditions, and the decrease in HR became progressively smaller over the three sessions. Consequently RT-data and HR-data (interpreted as indicating level of arousal) provided contra-indications of changes in driving proficiency.

- 009 Laurig, W., Becker-Biskaborn, G. U., & Reiche, D. Software problems in analysing physiological and work study data. Ergonomics, 1971, 14, 625-631.

In analysing man-work relations in ATC-tasks correlations between stress and strain factors are of importance. In field research the variables of stress and strain factors represent time series, the analyses of which call for some caution. When testing correlations between time series, the effect of serial correlation has to be considered. The calculation of regression coefficients for the description of the relation between serial correlated variables requires assumptions about the validity of the least square procedure. After taking into consideration further analyses of the residuals and serial correlation effects a combination of stress factors was used to determine the strain factor 'heart rate' of a radar controller. The coefficient of multiple determination reached about 80 per cent.

- 700 Laville, A., & Wisner, A. Etude electromyographique des muscles de la nuque au cours d'une tache de precision. [An electromyographic study of the neck muscles during a precision task.] Journal de Physiologie, 1965, 57, 260.

Posture, heart rate, and the electromyogram (EMG) of the neck muscles were measured in 13 Ss carrying out a task whose precision and speed of movements could be varied independently. Performance stabilized for each difficulty level, and in all Ss the neck-muscle EMG increased progressively during a 2 hr session. The integrated EMG correlates with the subjective stress of a demanding, precise task, and appears to be the most sensitive indicator in the situation studied.

- 701 Lawler, K. A. Psychophysiological correlates of attention in children and adults: I. The effects of uncertainty and motivation. II. The cardiac-somatic relationship (Doctoral dissertation, The University of North Carolina at Chapel Hill, 1974). Dissertation Abstracts International, 1975, 35, 4224B. (University Microfilms No. 75-4843)

Twenty-five fifth grade boys and 25 male college students were used as subjects in a discriminative RT situation. The warning signal was a light, followed in five seconds by one of two tones, the respond signal, to which the subject depressed either a right- or a left-hand key. Uncertainty was manipulated by varying the ability of the warning signal to predict the appropriate response. Motivation level was varied by having one session as a practice or learning session, and another where speed and accuracy were important.

The variable of motivation was differentiated by HR, forearm EMG, GBM (General Body Movements), and RT. Tonic levels of HR and forearm EMG increased during motivation, while GBM activity decreased. Phasic changes in these responses also differentiated the effect of motivation; during session 2, HR decelerated more, forearm EMG increased, and GBM activity decreased. In addition, RT responses were faster during session 2.

Only HR and RT responded systematically to changes in uncertainty. As uncertainty increased, HR accelerations increased, and HR decelerations decreased. Reaction time responses also increased with increases in uncertainty. There was no somatic response that differentiated this effect.

The development of the pattern of HR, forearm EMG, and chin EMG responses was also examined over the first eight trials. Both HR and forearm EMG required from four to eight trials to develop, while chin EMG showed its largest response on trial 1, and then subsequently decreased.

The discussion considered two main points: the reliability of HR deceleration as an index of attention and the relationship of cardiac and somatic responses. Since increases in uncertainty did not produce increases in HR decelerations, the confounding of attention with task difficulty was considered. With regard to the cardiac-somatic relationship, a model was proposed linking HR and relevant muscle activity in a functional relationship, and separating HR from irrelevant muscle activity.

- 702 Lawler, K. A., Obrist, P. A., & Lawler, J. E. Cardiac and somatic response patterns during a reaction time task in children and adults. Psychophysiology, 1976, 13, 448-455.

Psychophysiological responses were studied in 25 fifth grade boys and 25 male college students during a choice reaction time task. Attention to the task was manipulated through changes in two variables: uncertainty and motivation. Heart rate responses reflected changes in uncertainty for both groups. Heart rate, forearm EMG, eye blinks and movements, and general body movement differentiated between two levels of motivation. These results indicated that children and adults responded similarly, and that heart rate and forearm EMG were the most sensitive indices of changes in stimulus variables. Further examination of cardiac and somatic responses revealed an association between cardiac and task-relevant somatic activity. A study of response patterns over trials confirmed this relationship, which was discussed in terms of a two-process model.

- 703 Lazarus, R. S., & McCleary, R. A. Autonomic discrimination without awareness: A study of subception. Psychological Review, 1951, 58, 113-122.

1. GSR evidence is presented to indicate that at tachistoscopic exposure speeds too rapid for conscious discrimination (as measured by the subject's inability to report which stimulus was presented), the subject is still capable of making a discrimination. We suggest that the level of perceptual activity indicated by this finding be called subception.

2. It is important to control for unequal preference for stimulus material before drawing conclusions about the accuracy of perceptual recognition.

3. Pairing some of the stimuli with electric shock does not result in a change in the frequency with which they are accurately identified at various exposure speeds.

4. Some of the implications of this experiment for perceptual and clinical theory are discussed.

- 704 Leavitt, F. EEG activation and reaction time. Journal of Experimental Psychology, 1968, 77, 194-199.

The covariation of reaction time and alpha desynchronization was investigated at foreperiods of 200, 500, 1,500, and 4,000 msec. The results demonstrated that reaction time and alpha desynchronization are significantly influenced by variations in the foreperiod condition. Reliably faster RT and maximal alpha desynchronization occurred 500 msec after the warning signal; however, within the context of the foreperiod, the 2 variables did not covary. A unitary underlying arousal process was rejected in favor of multiple neural arousal processes.

708 Lecret, F., & Pottier, M. La vigilance, facteur de securite dans la conduite automobile. [Vigilance as a safety indicator in car-driving.] Travail Humain, 1971, 34, 51-68.

In order to evaluate the effects of real life driving on vigilance, 31 subjects have been used during 106 test sessions in a series of experimentations with increasing driving periods.

The principal parameters were as follows:

- electrical activity of the cerebral cortex (EEG);
- heart rate frequency (EKG);
- spontaneous blinks of the EOG;
- electrical activity of the neck muscles (EMG);
- variations of skin resistance (GSR);
- steering wheel movements;
- gas pedal movements.

In a preliminary experimentation, four driving situations were tested:

Electrophysiological parameters show different levels of vigilance: the highest arousal corresponding to a driving situation in town, a monotonous driving at night induces a particularly low arousal.

Then a first experimentation was conducted for the purpose of studying the decrease of vigilance through two and four hours of driving, on the motor way.

Secondary effects were shown: initial and final effect of the test, and toll bar crossing, increased to high but temporary degree.

The second part of the study followed up with two long driving tests on the motorway during a longer period of time (6 hours), with and without resting periods. The influence of long driving and the efficiency of rest pauses on driver alertness were shown.

For any session, with or without rest periods, similar development appeared for most of the parameters during the two last hours.

These experimentations give the matter for recommendations in the context of safe driving.

- 708 Lee, W. M. Spontaneous electrodermal fluctuations as an index of variability in attention and eye utilization (Doctoral dissertation, The Catholic University of America, 1969). Dissertation Abstracts International, 1969, 30, 1885C-1886C. (University Microfilms No 69-16, 329)

The present study was undertaken to test the thesis that spontaneous fluctuations (SF) in electrodermal level are associated with deficits in cortical inhibitory controls of activation.

Electrodermal recordings were obtained under resting conditions from patients at a Veterans Administration general medical and surgical hospital. Subjects displaying fewer than three 30 second intervals in which a 6/10 skin fluctuation occurred were placed in the low fluctuation group while those displaying four or more such intervals were placed in the high fluctuation group. Each group consisted of 25 subjects.

It was found that high SF subjects made a significantly greater ($t = 3.46, p < .005$) number of responses to irrelevant light intensity changes during a vigilance task, the impulsivity measure employed, than low SF subjects. High SF subjects were also found to display greater difficulty in inhibiting the response of reading a printed color name in favor of the required response of naming the color of the printed word when their color-word interference scores were compared with those of low SF subjects ($t = 2.37, p < .025$). Subjects displaying few fluctuations were found to refer to the standard stimulus more frequently during a size estimation task ($t = 3.58, p < .0005$) and, during the vigilance task, noted more light omissions from a spatial array of sequentially flashing lights than did subjects displaying frequent fluctuations ($t = 5.37, p < .0005$). It was also demonstrated that high SF subjects utilized fewer cues in discriminating between geometric figures on the basis of subsequent cues consisting of parts of one of the figures ($t = 2.03, p < .05$) and required more time to locate cues pertaining to an embedded figure ($t = 2.14, p < .05$).

- 709 Lagewie, H., Simonova, O., & Creutzfeldt, O. D. EEG changes during performance of various tasks under open- and closed-eyed conditions. Electroencephalography & Clinical Neurophysiology, 1969, 27, 470-479.

Obtained telemetric EEG recordings of 8 healthy persons during rest and during performance of 4 different tasks with eyes closed and of 5 tasks with eyes open. Automatic analysis of temporo-occipital and fronto-central EEG yielded the following results: (a) when the eyes were open, temporo-occipital and fronto-central alpha activity were less than when the eyes were closed; (b) fronto-central "alpha" activity was decreased during performance; (c) performance produced a significant trend toward intermediate degrees of temporo-occipital alpha activity; and (d) the increase in synchronization with eyes open was independent of whether visual components were directly involved in the task.

- 700 Legewie, H., Simonova, O., & Creutzfeldt, O. D. Telemetrische EEG - Untersuchungen in Leistungssituationen. [Telemetric EEG- studies during high performance situations.] Wehrmedizinische Monatsschrift, 1969, 13, 95-101.

The high performance demands of modern man-machine-systems necessitate more widespread use of performance controls by telemetric EEG-registration. In contrast to the former, expensive methods used in space medicine the authors discuss problems and possibilities of routine EEG-registration. The authors particularly refer to suitable and economical computer analysis of the EEG. As an example of such use the authors present two model studies in which EEG criteria were determined under clearly defined rest and performance conditions. As the most significant result of these two studies it was found that mental tension is not generally associated with desynchronization of the EEG.

- 700 Lehmann, D., Beeler, G. W., Jr., & Fender, D. H. Changes in patterns of the human electroencephalogram during fluctuations of perception of stabilized retinal images. Electroencephalography and Clinical Neurophysiology, 1965, 19, 336-343.

Subjective reports of the spontaneous fluctuations of perception of a stabilized retinal image were recorded simultaneously with the subjects' EEG.

Periods of fade-out of the image showed a high correlation with the occurrence of EEG alpha trains, whereas periods of visibility were correlated with low voltage fast activity.

The consideration of motor reaction times and alpha blocking times or latencies to visual stimulation indicates that central processes control the time at which fluctuations of perception of a stabilized retinal image take place. These are not retinal events reflected in the higher levels at later times.

- 710 Lehmann, D., Beeler, G. W., Jr., & Fender, D. H. EEG responses to light flashes during the observation of stabilized and normal retinal images. Electroencephalography and Clinical Neurophysiology, 1967, 22, 136-142.

The EEG potential evoked by repetitive 3.2/s - flashes of light to the right eye was measured in six subjects; at the same time the left eye viewed various continuously presented targets, both in normal and in stabilized vision.

The following observations were made:

1. In stabilized vision, no significant change could be detected in the amplitude of the evoked potential during periods of clear visibility or of spontaneous fade-out.

Thus, the changes in the state of CNS activity, indicated by low voltage fast EEG during periods of image visibility versus alpha activity during periods of fade-out, are not reflected by the evoked responses.

2. The presentation of a structured target to the left eye in normal vision reduced the amplitude of the potential evoked by flashes to the right eye. If the same target was stabilized on the retina, there was less reduction in the amplitude of the evoked potential.

The greater reduction of amplitude of the evoked potentials during observation of the target in normal vision compared with the reduction measured during stabilized vision is interpreted as resulting from increased loading of the higher levels of the visual system in the former case; in this condition, fewer elements are available to participate in the evoked response to unpatterned light.

- 711 Lehmann, D., Jacewitz, M. M., Koukkou, M., & Madey, J. M. Multi-channel EEG field analysis: Sleep and wakefulness in humans. Electroencephalography and Clinical Neurophysiology, 1976, 30, 271. (Abstract)

Simultaneous amplification and recording in 48 channels is used for studies of the spatial properties of the human scalp EEG. Series of equipotential maps of the EEG field distributions are constructed. These maps reveal relatively simple field configurations during alpha activity; positive or negative maximal values of the fields remain in one, two or three small areas of preference during 70-80% of the time. The maximal values step from one preferred area to the other; clockwise or counter-clockwise sequences are observed in the case of three preferred areas. The average amplitude per electrode, an index for the degree of relief of the field distributions, reaches its periodic peak values at times when the maxima reside within preferred areas. The field distributions during sleep EEG are different from the fields during alpha EEG. During sleep spindles an anterior precentral-central area contains the field maxima; the fluctuations of the average amplitude per electrode occur at about 28 c/sec, but are less regular than the 20 c/sec fluctuations during alpha EEG. However, slow wave epochs during sleep show complex field distributions, sometimes with bilateral symmetry. During slow waves the highest relief of the fields typically is seen when precentral-central areas contain the positive field maximum.

- 712 Leifer, L. J., Otto, D. A., Hart, S. G., & Huff, E. M. Slow potential correlates of predictive behaviour during a complex learning task. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

RP, CNV, and P300 were studied in a complex probability learning task. RP correlated with transition class, CNV with predictive astuteness, and P300 with astuteness, event probability and the occurrence frequency of positive reinforcement. P300 analyses are consistent with the conception that learning occurs mainly during positive reinforcement trials.

- 713 Lester, J., Knapp, T. M., & Roessler, R. Personality, physiology, performance and sleep deprivation. Psychophysiology, 1976, 13, 180. (Abstract)

Groups formed from subjects selected for extreme scores on the Barron Ego Strength Scale (Es) and on the Barratt Impulsiveness Scale (BIS) differed in the number of signals correctly detected in a visual monitoring task during a 72-hr sleep deprivation experiment. Subjects who scored high on the Es scale detected more signals than did normal or low Es subjects. Subjects who scored low on the BIS also performed significantly better on the vigilance task. Sleep deprivation produced substantial decrements in heart rate and in four performance measures (omission errors, interrogation rate, reaction time, and word forgetting). There was significant covariation of heart rate and two performance measures, omission errors and interrogation rate, in particular for the low ego strength/high impulsiveness group, the personality group which showed the greatest deterioration of performance over the sleep deprivation period. Skin conductance was found to be lower for those subjects with high ego strength. The results are discussed in relation to the effects of personality types and physiological arousal on performance during sleep deprivation.

- 714 Levinson, J. B., & Fenz, W. D. The effects of motivation on cardiac activity. Journal of Psychology, 1971, 78, 11-26.

Investigated the relationship between motivation and cardiac activity in anticipation of, during, and following the completion of an attentional task. Thirty male undergraduates were randomly divided into 3 groups: 1 receiving high, 1 low, and 1 "neutral" motivational instructions. Measures of heart rate were obtained for each S over 30 trials, each being segmented into 4 periods for heart rate analysis. The analysis yielded highly significant group interactions with both time and trials indicating that the motivational instructions did exert a reliable influence upon cardiac activity. It was found that increases in motivation, while not affecting the overall pattern of the cardiac response, lead to increases in the amplitude of the response. Results are also discussed in terms of S's level of attention.

- 715 Levonian, E. Attention and consolidation as factors in retention. Psychonomic Science, 1966, 6, 275-276.

The skin resistances of Ss (61 high school students) were recorded during a 10-min instructional film, and Ss were tested for retention of information immediately after (short term) and 1 wk after (long term) the film. Resistance decrements which preceded information presentation (predecrements) led to short-term and long-term retention, whereas postdecrements led to reminiscence. These results are interpreted in terms of attention and consolidation.

- 716 Levonian, E. Evoked potential in relation to subsequent alpha frequency. Science, 1966, 152, 1281-1282.

The 12 lower-frequency trials yielded an average EP with positive deflections at about 40 msec and, thereafter, at increments of about 100 msec, and with negative deflections evenly spaced at intermediate points. Relative to this curve, the 12 higher-frequency trials yielded an average EP whose deflections are not only opposite in sign but are also attenuated. The average for all 24 trials yielded an attenuated copy of the average EP obtained from the 12 lower-frequency trials, as might be expected. The first three positive and negative peaks of the 12 lower-frequency trials differ significantly at the .01 level from the six time-associated points of the 12 higher-frequency trials.

These results indicate that the process of averaging over all trials may be misleading if it is assumed that the trials are drawn from a homogeneous population.

Finally, I have assumed that the relation between the evoked potential and subsequent alpha frequency is based on trial-to-trial variation in attention. However, since attention was not measured independently in this study, alternative explanations, such as that based on the phase of alpha at the time of stimulus presentation, cannot be discounted.

- 717 Levonian, E. Retention over time in relation to arousal during learning: An explanation of discrepant results. Acta Psychologica, 1972, 36, 290-321.

Arousal increment (more simply, arousal) during learning is related to subsequent retention. Published results are discrepant. In some studies physiologically higher arousal, relative to lower is related to better short-term (a few minutes) and long-term (30 min or more) retention. In other studies higher arousal is related to poorer short-term and better long-term retention. Both results are explained here in terms of the retentivity-accessibility hypothesis, which is derived in this article on the basis of an analysis of methodological differences between studies obtaining the two results. The hypothesis states that high arousal is associated with strong retentivity but poor short-term accessibility. The hypothesis is evaluated on the basis of its compatibility with published results.

- 718 Libby, W. L., Jr., Lacey, B. C., & Lacey, J. I. Pupillary and cardiac activity during visual attention. Psychophysiology, 1973, 10, 270-294.

Thirty pictures, rated on 22 scales, were shown to 34 male undergraduates while pupillary diameters and heart rates were recorded, to test the prediction that attention to the environment leads to sympathetic-like dilatation and parasympathetic-like cardiac slowing. The relationships of the responses to stimulus-attributes also were studied. The prediction was satisfied, demonstrating directional fractionation and situational stereotypy. Tonic levels changed significantly during the experiment and also showed directional fractionation. A few Ss and stimuli, however, yielded reliable pupillary constriction, demonstrating intrastressor stereotypy. Four factors characterized the ratings, 2 of which were associated with the autonomic responses. Pupillary dilatation and cardiac slowing increased as the Attention-Interest value increased. Pupillary dilatation was greatest to pictures midway on the Pleasantness-Evaluation factor, and greater to unpleasant than to pleasant stimuli. Cardiac slowing was linearly related to pleasantness, with unpleasant stimuli provoking the greatest slowing. The 2 responses were correlated less than measurement reliability would have allowed, demonstrating quantitative dissociation. When base-corrected scores were used the correlations again were low and highly variable among Ss and stimuli, even in direction.

- 719 Liberson, W. T., & Liberson, C. W. EEG records, reaction times, eye movements, respiration, and mental content during drowsiness. In J. Wortis (Ed.), Recent advances in biological psychiatry. New York: Plenum Publishing Corporation, 1966.

1. A few seconds preceding the onset of drowsiness (alpha-blocking), slow eye movements appear. The incidence of these movements increases during the first 10 to 15 sec of drowsiness. Then these movements decrease during the later periods of drowsiness and usually disappear when spindles occur.

2. Respiration becomes less regular during the first 20 sec of drowsiness, then recovers its regularity.

3. The latency of motor reaction times increases linearly during the first 30 sec of drowsiness, as the incidence of feelings of sleepiness increases. However, only 50% of the subjects reported evidence of drowsiness and/or the presence of hypnagogic images during the first 30 sec of continuous EEG drowsy pattern.

- 720 Lieblich, I. Manipulation of contrast between differential GSR responses through the use of ordered tasks of information detection. Psychophysiology, 1969, 6, 70-77.

Identified 3 variables involved in the production of Short Term Physiological Activation (STPA): (1) frequency of usage of the stimulus by the organism, (2) relevance of the stimulus to the organism, and (3) whether a verbal response to the stimulus is required. Stimulus sequences for information detection were constructed by combining these variables, and physiological responsiveness was observed in the GSR. It was hypothesized that short term physiological responsivity could be manipulated in an ordered fashion using combinations of the variables. Fifty-four undergraduates were tested in 6 experimental sequences. It was possible to manipulate the contrast between the GSRs emitted by the S to the critical stimuli, and those produced to the alternative stimuli in information detection tasks in the predicted direction.

- 721 Liederman, P. H., & Shapiro, D. Studies on the galvanic skin potential level: Some behavioral correlates. Journal of Psychosomatic Research, 1964, 7, 277-281.

The galvanic skin potential (GSP) level was recorded continuously in several groups of male subjects under a variety of stimulus conditions. GSP was relatively low during conditions of sleep, intermediate during a monotonous learning task, and relatively high during presentation of unpleasant stimuli and wakefulness in a sensory deprivation situation. The findings suggest that GSP can provide a simple objective technique for recording varying states of behavioral activation.

- 722 Lifshitz, K. Cortical evoked potentials to emotionally significant visual stimuli. Paper presented at the 120th annual meeting of the American Psychiatric Association, Los Angeles, May 1964.

With the relatively recent advent of computer averaging techniques there has been considerable interest in the evoked cortical potentials in human subjects. These potentials ordinarily invisible in the ongoing "noise" of the electroencephalogram can be made visible by averaging because of their fixed occurrence in time following a stimulus. There have been numerous reports of investigations on the evoked potentials resulting from stimuli delivered through the visual, auditory and somesthetic systems. However, investigations of the effects of stimuli, which are emotionally laden and/or contain coherent information, on the evoked potentials have not been reported.

By utilizing a series of 35 mm color slides projected on a screen as the visual stimulus producing the evoked potential we have been able to introduce stimuli of a controlled informational and emotional content. The cortical evoked potentials of normal adult male subjects to this form of visual sensory input has been investigated. Evoked potentials are recorded from scalp electrodes. The sweep of the "CAT" computer is triggered by the projected slide. We have investigated three principal circumstances thus far: The responses to projected "art" slides laden with emotional content of a sexual nature; scenic slides of no particular emotional charge; and as a control situation, to obtain the same light value stimulus but to decrease the information content, these slides have also been projected out of focus.

These various situations lead to evoked cortical potentials which show differences both in the early components and in the later components. Thus, from scalp electrodes we can observe, in man, evidence of differences in the processing of data with different types of emotional content.

The nature of the evoked potential changes and the effects of repetition will be discussed in greater detail.

- 723 Lifshitz, K. The averaged evoked cortical response to complex visual stimuli. Psychophysiology, 1966, 3, 55-68.

Averaged cortical evoked responses in man to repetitive informationally complex pictorial stimuli, as opposed to other visual stimulation, were obtained from scalp electroencephalographic (EEG) recordings. The method used involved the projection of lantern slides. Included were three different categories (indifferent scenic, repulsive medical, and nude female photographs) assumed to evoke, respectively, neutral, negative, and positive reactions in the normal young male subjects. In all subjects, recordings from occipital or occipitoparietal scalp leads consistently resulted in evoked response patterns to pictorial slides measurably differing from responses to these same slides made non-associational through defocusing, or to blank light flashes. Responses to pictorial stimuli were also different than those to motivated observation of projected words, colors, or geometric patterns. The evoked responses to the three different categories of pictorial stimuli also showed significant differences. These differences were not as marked and were clearly replicable only for some subjects.

- 724 Lifshitz, K. An analysis of information handling indicated by the AER in normals and schizophrenics. Paper presented at the 124th annual meeting of the American Psychiatric Association, 1968.

In this study the AERs to a number of related stimuli are recorded from the scalp in ten normal subjects and ten chronic schizophrenic subjects. The stimuli used to obtain the AERs are characterized as "simple stimuli" and "complex stimuli". The simple stimuli are: a blue light field, a red light field, a black and white checkerboard pattern, and a tone burst. The complex stimuli are a red and blue checkerboard pattern, and the simultaneous presentation of a red light field and a tone burst. The visual stimuli are obtained by the projection of slides onto a viewing screen. The simultaneous information content of the complex stimuli is considered to be contained in the combined content of the individually presented simple stimuli. The intent of this approach is to obtain not only information concerning the relationship between a stimulus and the AER but also some insight into the nature of information processing in the brain. In this case we are comparing the information processing of separately presented simple stimuli and the more complex situation arising when the stimuli are simultaneously presented. The latter instance requires the processing of more data and necessitates an interaction of elements. By this approach we may obtain additional insight into the difficulties encountered in various pathological states in the handling of multiple simultaneous stimuli. In particular, we are interested in the "information overload" concept as applied to schizophrenia.

- 725 Lille, F., & Pottier, M. Interet des potentiels evoques corticaux dans l'etude de l'activite mentale. [Cortical evoked potentials in the study of mental activity.] Travail Humain, 1972, 35, 59-67.

Studied visual and auditory cortically aroused potentials. Waves were picked up by electrodes over the occipital and temporal areas. When stimulation was in the same sense, the amplitude decrement and duration of recovery period were proportional to the difficulty of the mental task. When stimuli alternated between the 2 senses, there was a partial masking of these findings.

- 726 Lindsey, J. W. Binaural analysis as a function of physiological masking: The cardiac cycle (Doctoral dissertation, University of North Carolina at Greensboro, 1972). Dissertation Abstracts International, 1972, 33, 1821B-1822B. (University Microfilms No. 72-26, 258)

Two experiments were conducted in an effort to determine the relationship between auditory signal detectability and the S's EKG (cardiac cycle).

Data were collected according to a yes/no, signal detection paradigm in repeated measures designs. Three males served as trained subjects. The S's task was to indicate (by pushing one of two microswitches) his decision concerning the presence of a 100 msec signal with a 0.5 a priori probability of occurrence. Experiment I investigated the following parameters: (1) Signal Delay: 0.0 and 0.5 sec following the EKG R-wave; (2) Signal Frequency: 100, 200, and 300 Hz; (3) Listening Condition: SO (in-phase) and S_r (inverted phase). Experiment II examined the same delay and listening conditions as Experiment I but at 5000 Hz. Subjects received a quasi-random schedule of these parameters. The dependent variable was signal detectability as measured by d'. Two hypotheses were studied. First, it was predicted (based on the frequency spectrum of cardiac sounds) that depressed detectability (masking) would be found at 0.0 sec signal delay (re 0.5 sec) at 100, 200, and 300 Hz, but not at 5000 Hz. Second, detection advantages for S_r re SO were predicted to be largest when the signal was coincident (0.0 sec) with the R-wave of the EKG.

The experiments indicated support for the first hypothesis since binaural (SO and S_r) detection was significantly improved by presenting the signal 0.5 sec after the EKG R-wave rather than coincident (0.0 sec) with it. However, contrary to the second hypothesis, detection differences between SO and S_r were not influenced by signal delay; that is, the advantage for S_r re SO was not larger at 0.0 sec than at 0.5 sec. Rather, sensitivity for SO was significantly better than S_r for all conditions except one.

The results were discussed in terms of the cardiac masking hypothesis.

- 727 Lindsley, D. B. Attention, consciousness, sleep and wakefulness. In J. Field, H. W. Magoun & V. E. Hall (Eds.), Handbook of physiology (Vol. 3). Washington, D. C.: American Physiological Society, 1960.

Wakefulness is maintained by excitation of the reticular formation and the ARAS through collaterals from all sensory pathways, by corticofugal impulses originating in various regions of the cortex and by humoral factors which affect particularly the rostral portions of the reticular formation. Increased activity in the ARAS through any of these sources of excitation acts upon the cortex by changing the pattern of its electrical activity from the slow waves and spindle bursts of sleep, or the alpha waves of relaxed wakefulness, to a pattern of low-voltage fast waves, commonly referred to as 'activation'. Electroocortical activation is accompanied by behavioral arousal and by alertness and attention.

The elusive term 'consciousness' has been considered as a graded form of awareness, ranging from the simplest perceptual discriminations to the more complex cognitive forms of abstraction and thinking. It has no precise locus on the sleep-wakefulness continuum described in terms of EEG patterns, behavioral characteristics and states of awareness. Unconsciousness in which perceptual contact with the environment is lost can be identified roughly with the onset of sleep in Stage C of the EEG in which delta waves and 14-per-sec spindle bursts predominate.

Attention is closely allied to arousal and wakefulness and, like wakefulness and consciousness, appears to be a graded phenomenon extending from general alerting, as in the orienting reflex, to specific alerting, as when attention is focused upon a given sense mode and dominates sensory input to the point of exclusion of other sense modes. Still higher or more finely focused attention may be restricted to a limited aspect of a given sense mode.

Recent neurophysiological findings have been considered which not only broaden the scope of modern concepts of brain organization and function, but bear specifically upon the mechanisms which may underlie and subserve the processes of attention, perception and learning.

720 Lindsley, D. B., Electrocortical correlates of temporally ordered visual phenomena. Acta Psychologica, 1964, 23, 201-202.

Digital computer techniques were employed to bring out the cortical evoked potentials to the paired visual stimuli as well as to the TF (test flash) and BF (brighter flash) separately. Paired stimuli with inter-flash delays of 250 or 500 msec gave no perceptual interaction (two flashes seen) and evoked potentials (EPs) to TF and BF are separated and differentiated. For inter-flash delays of 100, 60 and 40 msec, the region in which brightness enhancement of TF occurs, the EP for the BF appears to merge with that of the TF. By contrast, at 20 msec delay between stimuli, where the first stimulus is perceptually blanked by the second, the EP appears to be that of the BF displacing that of the TF. Hypothetical EPs were constructed by algebraically summing the EPs for separately recorded TFs and BFs and allowing appropriate delay intervals. These synthesized pairs gave EPs closely similar to the EPs for actual paired flashes, suggesting that for certain temporal intervals brain processes function in an additive manner.

720 Lindsley, D. B. Average evoked potentials — achievements, failures and prospects. In E. Donchin & D. B. Lindsley (Eds.), Average evoked potentials: Methods, results, and evaluations. Washington, DC: US Government Printing Office, 1969.

Among the topics discussed in this review of animal and human evoked potential research are:

Early history of evoked potentials and the EEG.

Early investigations of brain potentials in the USA.

Sources of the EEG.

Some further historical notes.

Average evoked potentials: Problems and prospects.

Locus, variability and components of the AEP.

Nature and sources of evoked potentials.

Spatio-temporal distribution of potentials.

Average evoked potential and attention.

Specific and nonspecific sensory systems.

Slow potential shifts: The CNV.

Central and peripheral factors in AEP.

- 730 Lindsley, D. B. Neurophysiological mechanisms of attention and perception: Their role in information processing in the visual system. In D. P. Kimble (Ed.), Readiness to remember: Proceedings of the third conference on learning, remembering and forgetting. New York: Gordon and Breach, 1969.

Data are presented in this report which relate differences in the average evoked potential to correctly detected and missed signals in a vigilance task.

- 731 Lindsley, D. B., & Emmons, W. H. Perception time and evoked potentials. Science, 1958, 127, 1061. (Abstract)

Perceptual blanking is believed to occur at the cortical level, when the arrival of impulse discharges from the second stimulus interfere with the consolidation processes of those from the first stimulus. The recording of evoked potentials from over the visual area of the brain provides data on latency, form, and duration of evoked potentials which tend to support the argument that perception time is a cortical phenomenon. Evoked potentials were reconstructed by an algebraic summation method from multiple oscillograms.

- 732 Lindsley, D. B., & Emmons, W. H. Perceptual blanking, evoked potentials and perception time. Electroencephalography and Clinical Neurophysiology, 1958, 10, 359. (Abstract)

Four, normal, adult subjects practiced in making perceptual judgments were tested with three intensities of the second or "blanking" flash. A set of three curves of similar form was obtained for each subject, showing the period of complete blanking of the first stimulus by the second to be about 25 msec whereas partial blanking continued until 45 msec after the onset of the first flash. Since perception of the first informational flash was no longer interfered with by a second non-informational flash following by 45 to 50 msec this period of time may be taken as "perception time" or perhaps "cortical consolidation time". In confirmation of this are evoked potentials recorded from the occipital area. Reconstruction of the form and latencies of the components of the evoked potentials by a repetitive method of cancelling random activity has permitted a correlation between perception time and the electrophysiological events.

- 733 Lindsley, D. B., Seales, D. M., & Wilson, G. F. Changes in the late components of visual evoked potentials with visual information processing. Society for Neuroscience Abstracts, 1973, 422. (Abstract)

Thus changes in P2 appear to be correlated with the complexity of the visual information processing task but mainly over visual association areas. The contrast between these changes and those observed under conditions of increased arousal, where late components are broadly enhanced, are interpreted in terms of specific and nonspecific sensory systems.

- 784 Lindsay, D. B., Wilson, G. F., & Seales, D. M. Evoked potentials and information processing. Electroencephalography and Clinical Neurophysiology, 1974, 36, 213. (Abstract)

It is concluded that the processing of visual information, whether in making simple discriminations or in more complex discriminations following pattern-number code learning, modifies the late positive component, P2, of the AEPs over visual association cortex (area 18) and to a lesser degree over Wernicke's areas (areas 39 and 40). No such changes were observed at the vertex (area 4). In general, the more complex the visual information processing the greater were the changes in the P2 wave over the occipital area.

- 785 Lipscomb, H., Rummel, J., Dietlein, L., & Vallbona, C. Circadian rhythms in simulated and manned orbital space flights. Aerospace Medicine, 1966, 37, 288. (Abstract)

Growing interest focuses upon the role of biological rhythms in homeostasis. Evidence has accumulated to suggest that disruption of human circadian rhythms leads to decrements in performance of discrete sensory-motor tasks. Changes in light intensity and duration would appear to be the most important exteroceptive cues to rhythmicity, and evidence will be presented to support this concept. Abrupt changes in lighting regimens have resulted in disruption of physiologic, biochemical, and psycho-physiologic parameters in simulated flights, and performance of tasks requiring meticulous attention to detail is seriously impaired during periods in which rhythmic biological function is disrupted. Time perception and the ability to repeat timed auditory and visual signals is adversely affected. Data derived from in-flight physiological monitoring of manned orbital flights has also been subjected to analysis for circadian periodicity, and results of this analysis will be presented.

- 786 Lisper, H. O., Laurell, H., & Stening, G. Effects of experience of the driver on heart-rate, respiration-rate, and subsidiary reaction time in a three hours continuous driving task. Ergonomics, 1973, 16, 501-506.

Hypothesized that there would be differences in effects of continuous driving on experienced and inexperienced drivers. Ten male 18-26 yr old undergraduates served as Ss; inexperienced Ss all had new driver's licenses and a total driving distance of less than 2,000 km, while experienced Ss all worked as parttime taxi drivers and had an annual mileage of more than 20,000 km. The 270-km test drive was conducted on a 4-lane highway. Heart rate and reaction time (RT) to an auditory stimulus were recorded for each S during the drive. Inexperienced Ss had marked increases in RT while experienced Ss showed decreases. Decreases in heart rate were significantly greater for the experienced group ($p < .01$). RT was considered to be the more important variable in evaluating the effects of long distance driving. A change in approach in studying driving fatigue is recommended.

- 787 Litsov, A. N. Eksperimental'noe izuchenie autochnoi periodiki fiziologicheskikh funktsii i rabotosposobnosti cheloveka pri sdvinutom rasporiadke sna i budstsvovaniia. [Experimental study of diurnal dynamics of physiological functions and performance of men during normal and altered activity cycles.] Kosmicheskaja Biologija i Meditsina, 1969, 3, 59-66.

A drastic alteration of work-rest cycles (sleep – 14 to 23 o'clock and vigilance – 23 to 14 o'clock) caused a gradual reconstruction in physiological functions and performance pattern of six healthy pilots used as test subjects. The reconstruction included three – latent, visible and deep – stages. The rate with which different functions of the human body adjusted to a new environment varied: EEG and simple motor reactions changed with the highest rate while autonomic functions and complex highly-coordinated mental activity changed with the lowest rate. The reconstruction of diurnal rhythmicity in the experimental conditions was significantly affected by the pattern of physical and mental activity and sleep of the test subjects, and their motivation. The dynamics of the reconstruction of physiological functions, performance and sleep of human beings should be considered as the best indication of the human adaptation to an altered pattern of activity.

- 788 Litsov, A. N. Experimental study of the diurnal rhythm of physiological functions, performance and sleep in man modified regimes with double alternation of sleep and wakefulness. Space Biology and Medicine, 1973, 7, 118-128. (NTIS No. JPRS-60471)

The dynamics of diurnal rhythm of physiological functions, work performance and sleep of test subjects exposed to two schedules with a double alternation of work and rest exhibited the same three stages (latent, apparent and deep) which were observed under other schedules. The adaptation of test subjects to this alternation of sleep and wakefulness may adhere to a fractioned (4 + 4 hours and 6 + 2 hours), displaced (4 + 0.6 + 0 hours) or mixed (fractioned, disturbed and refractioned) schedules. The best schedule was a cycle with 6 + 2 hours of sleep. A schedule with two equal sleep cycles can be used temporarily to solve operational or emergency problems as well as an intermediate one.

- 789 Liu Shih-yih; Wu Chin-eh; Sun Shih-luh; Ko Chih-yun, & Liu Yung-tsai. [The influence of mental activity (mental calculation) on the EEG in subjects of different ages.] Acta Psychologica Sinica, 1964, 3, 281-288.

A study of the influence of mental activity on the EEG was carried out on 359 Ss from 4-86 yr of age. Different EEG alterations were obtained during mental activity. Often no EEG modification was found between 4-7 yr of age; more and more EEG modifications were noted with increase in age. Theta-waves were more frequently observed between 8-17 yr of age, and diffusely alpha-blocking over the whole cortex was most marked in Ss between 8-60 yr of age. EEG alterations, associated with mental calculation, were found to be localized mainly in the left temporal and the frontal regions in Ss of different ages.

- 740 Livanov, M. N., Gavrilova, N. A., & Aslanov, A. S. Intercorrelations between different cortical regions of human brain during mental activity. Neuropsychologia, 1964, 2, 281-289.

(1) In human subjects at rest the electrical activity of half of the recorded areas takes an independent course. Correlations in the high percentage of time are, as a rule, very few (only sometimes do they amount to dozens). Interaction between the remaining areas takes place mostly in the low percentage of time.

(2) During mental activity the pattern of bioelectrical mosaic is changed. Correlations occurring and correlations between different cortical areas in a low percentage of time form a dense network of functional connections spreading throughout the cortex. Against this background, correlations in the high percentage of time appear, their number amounting to a hundred or more.

(3) They localize predominantly in the anterior parts of frontal lobes and in the motor analyzer area.

(4) The direction of correlations is found to agree with the morphological paths. This gives us grounds to believe that these correlations reflect, to some extent, functional connections of the cortex.

(5) The process bears a wave-like character.

(6) Distinct changes of correlations are registered only during sufficiently difficult mental work. An easy task hardly evokes any changes of correlations.

- 741 Livanov, M. N., Gavrilova, N. A., & Aslanov, A. S. Vzaïmnye korreliatsii mezhdu razlichnymi uchastkami kory golovnogogo mozga cheloveka pri umstvennoi rabote. [Cross-correlations between various points of the human brain during mental work]. Zhurnal Vysshei Nervnoi Deiatel' nosti, 1964, 14, 185-194.

Spatial correlation of biopotentials of various cortical points was studied in healthy subjects during mental work. The investigations were made by the electroencephalography with simultaneous recording of 50 points of the cortex. The resulting data were processed on a computer.

In a state of "rest" the correlations of the biopotentials in individual cortical points are not numerous. Electrical activity of half of the recorded points proceeds independently of each other; the biopotentials of the rest of the cortical points correlate at a low percentage of time.

During brain work (arithmetical counting), the correlations of biopotentials appearing between the individual cortical points at a low percentage of time create a wide network of functional "connections" throughout the cortex. Against this background there emerge many biopotential correlations observed at a high (over 75%) percentage of time. The correlating points are localized primarily in the anterior parts of the frontal areas and the motor analyzer area. Distinct changes in correlations are recorded only in cases of sufficiently difficult work.

- 742 Lockhart, R. A. Cognitive processes and the multiple response phenomenon. *Psychophysiology*, 1973, 10, 112-118.

The phenomenon of multiple autonomic responding is analyzed in terms of the component responses of the multiple response pattern (CS-R, PRE-US-R, POST-US-R). CS-R is interpreted as a function of two mechanisms: (1) an orienting response sensitive to temporal and event uncertainty, and (2) a component sensitive to stimulus sequence. Both components are subject to cognitive control, but also appear operative in cognitively deficient populations (e.g., the mentally retarded). PRE-US-R is interpreted as unique to language-capable humans and manifested when perceptual-verbal processes actually are involved in S's interaction with the stimulus paradigm. It is, perhaps, an autonomic correlate of "awareness." POST-US-R is interpreted as the earliest development of a neuronal model of stimulus sequence, but subject to enhancement or suppression via cognitive factors. When the human subject has full possession of his cognitive and symbolic processes and relates to the conditioning paradigm in terms of these processes, conditioning phenomena will be quite different than when these processes are absent or directed into nonparadigm-related activities. The effect of rendering cognitive processes dysfunctional cannot be predicted from autonomic behavior mediated by cognitive processes operating naturally and without interference.

- 743 Loeb, M., & Alluisi, E. Influence of display, task, and organismic variables on indices of monitoring behavior. *Acta Psychologica*, 1970, 33, 343-366.

The effects of a number of variables known to influence monitoring behavior are reviewed. The principal models for such behavior are considered in the light of the findings. It is suggested that all of these have merit in explaining some of the data and that none of them satisfactorily explain all of them.

- 744 Lombroso, C. T. The CNV during tasks requiring choice. In C. R. Evans & T. B. Mulholland (Eds.), *Attention in neurophysiology*. London: Butterworths, 1969.

The observation of a considerable lag in time between changes in the configuration of the CNV and in the concomitant behaviour of the subject, could be interpreted as negating at least some of the attributes proposed for the CNV, and briefly summarized above. It seems possible to doubt, for instance, that the CNV represents a cortical 'priming' process within the frontal cortex for the discharge of motor neurones, when it may take literally minutes before a significant change in its configuration 'catches up', so to speak, with the change in performance. It is conceivable that the CNV represents many and different phenomena, some being 'neuronal' in origin; surely, its components relating to the cortical response evoked by the stimuli are neuronal. However, within any cortical area where populations of neurones become 'active', there are parallel metabolic processes which also involve non-neuronal elements, such as glial cells, capillary endothelial cells and the like. It is conceivable that a study of such phenomena as the graded 'direct cortical response', or measurements of changes in regional blood flow and CO₂, might reveal closer relationships with certain components of the CNV. It is known, for instance, that significant changes in the impedance of small volumes of the cortex closely parallel relatively rapid shifts of blood flow and gas exchange, and specifically that the impedance of dendritic structures seems to take place in several of those behavioural situations in which negative d.c. shifts had been measured on the cortex. This would represent a kind of intracortical GSR, whose time basis might be much less rigid than one would expect from a causally related neuronal inter-action during a stimulus-response task.

The observations reported in this study seem, therefore, to add to the complexity of the precise nature of both the psychological and physiological processes underlying the phenomenon of the CNV.

- 743 London, H., Schubert, D. S. P., & Washburn, D. Increase of autonomic arousal by boredom. Journal of Abnormal Psychology, 1972, 80, 29-36.

Two experiments tested the effect of boredom on galvanic skin potential, skin conductance, and heart rate as autonomic measures of arousal. The results support Berlyne's 1960 hypothesis that boredom increases autonomic arousal. An intelligence measure correlated positively with rated boredom on the experimental task. The subjective state of boredom was seen as resulting from an inadequate rate of information flow. Inadequate information flow may result in increased autonomic arousal because of (a) S-produced arousal increase required to maintain focused attention on the task and/or (b) release of brain stem arousal centers by boredom-reduced cortical activation.

- 748 Lorenz, S. A., Jr., & Darrow, C. W. Eye movements, EEG, GSR and EKG during mental multiplication. Electroencephalography and Clinical Neurophysiology, 1962, 14, 739-746.

Data from ten subjects before and during mental multiplication may be summarized:

1. Each of the ten subjects showed a significant increase in eye movement rate (EMR) during mental multiplication. These data suggest that rapid ocular movement is a consistent concomitant of mental multiplication under the conditions described.

2. The increase in EMR during mental multiplication was not related to changes in heart rate, conductance level (CL), per cent time occipital alpha, or to the presence of a palmar galvanic skin response (PGR) following presentation of a problem, although a tendency was observed for those individuals with high CL's to have both PGR's and high EMR's.

3. Records of the six subjects scored for per cent time occipital alpha each showed a significant decrease in occipital alpha activity during mental multiplication attributable primarily to "blocking". No unique EEG wave forms were identified.

- 747 Loveless, N. E. Distribution of response to non-signal stimuli. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

The 'orienting response' to unpredictable stimuli appears to include a frontally-dominant negative complex and a centrally-dominant slow positive wave.

- 748 Loveless, N. E., & Sanford, A. J. The CNV baseline: Considerations of internal consistency of data. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 19-23.

Rebert and Knott (1970), suggesting that CNV latency is of the order of 400 msec, noted that this applies strictly only to the CNV as usually studied, i.e., with fixed and relatively short foreperiods. When long foreperiods are used, the slow potential change may take a form similar to that of the Bereitschaftspotential and have no discrete onset. Our results suggest rather that the CNV, of whatever duration, comprises two distinct phases: one has no inherent time relationship to the first stimulus but occurs in anticipation of the second; the other is a constant effect of the first stimulus, and constitutes, we suggest, a component of its orienting response.

- 749 Loveless, N. E., & Sanford, A. J. Slow potential correlates of preparatory set. Biological Psychology, 1974, 1, 303-314.

Eleven experienced undergraduate Ss performed a simple reaction time task under the classical normal, sensory, and motor set instructions. Computer averaging of the EEG confirmed that slow potential changes during the foreperiod could be analyzed into 2 components: an orienting response following the warning signal, and an expectancy wave anticipating the reaction signal. The orienting response was not affected by instructions, but the amplitude of the expectancy wave was proportional to changes in the level of preparatory set as inferred from reaction time. Interaction between this effect and the intensity of the reaction signal suggests that the expectancy wave reflects shifts of the criterion governing the intensity required to initiate a response. Some methods of investigating this possibility are suggested.

- 750 Low, M. D., Borda, R. P., Frost, J. D., Jr., & Kellaway, P. Surface-negative, slow-potential shift associated with conditioning in man. Neurology, 1966, 16, 771-782.

Using long time-constant recording techniques, paper write-out, magnetic tape storage, and electronic averaging, the phenomenon designated "contingent negative variation" (CNV) by W. Grey Walter and associates has been studied in 63 human subjects. This surface-negative slow potential was demonstrated during operant conditioning and during semantically induced states of "preparation to respond." It was recorded epidurally and from the scalp. Its appearance does not depend upon a particular pattern of eye movement, GSR, heart rate, or respiration. Neither the intensity nor modality of the conditioning stimuli affects its appearance. The maximum field of the potential is generally anterior to the parietal region and near the midline of the head.

The CNV appears to be a true correlate of the cerebral mechanisms associated with conation.

- 751 Low, M. D., Coats, A. C., Rettig, G. M., & McSherry, J. W. Anxiety, attentiveness-alertness: A phenomenological study of the CNV. Neuropsychologia, 1967, 5, 379-384.

The CNV of W. Grey Walter, a slow, surface-negative potential which appears maximally in frontal regions of the brain of man during psychophysiological states of "preparation set", is shown, in a non-patient population (a) to have no consistent relation to subject scores on an objective measure of manifest anxiety (IPAT) in a non-stressful experimental situation, and (b) to increase in amplitude and decrease in variability with heightened attentiveness-alertness.

- 752 Low, M. D., Frost, J. D., Jr., Maulsby, R. L., & McSherry, W. Electroencephalographic correlates of preparation set. Electroencephalography and Clinical Neurophysiology, 1958, 24, 286. (Abstract)

It was concluded that increasing the force required to accomplish R is associated with an increase in the magnitude (area) of the CNV, and that this increase is due to processes which are somehow altered when a simple mental task is imposed between S₁ and R.

It was also shown that CNVs are additive, although not linearly, if two anticipations are superimposed in time or if a subject is expecting to perform more than one response of the same kind.

These findings reinforce the concept that the CNV is a correlate of a complex state of physiological activation, mobilization or preparation set.

753 Low, M. D., & McSherry, J. W. Further observations of psychological factors involved in CNV genesis. Electroencephalography and Clinical Neurophysiology, 1968, 25, 203-207.

Experiments were done in man in an attempt to define more extensively the psychological factors involved in contingent or conative negative variation (CNV) genesis.

Two experimental designs were used. In the first, S_1 was a picture of a number, S_2 was a tone pip following S_1 by 1 sec, and R was depression of a plunger so constructed that the force required to depress it increased linearly with displacement from rest. S_1 indicated the level to which the subject must depress the plunger. In the second experiment, separate anticipations were created by presenting subjects with two different $S_1 - S_2 - R$ paradigms; then the two were presented superimposed in time.

It was demonstrated that:

1. CNVs are additive if two anticipations are superimposed in time or if a subject is expecting to perform more than one response of the same kind.

2. Increasing the force required to perform a response is associated with an increase in the magnitude of the CNV.

3. The interposition of a mental task between S_1 and R diminishes the degree of expected increase in CNV magnitude associated with increased force requirements of R.

754 Lubin, A., Hord, D. J., Tracy, M. L., & Johnson, L. C. Effects of exercise, bedrest and napping on performance decrement during 40 hours. Psychophysiology, 1976, 13, 334-339.

Young male Naval volunteers were denied normal nocturnal sleep and maintained on a 60-min treatment-160-min testing schedule during 40 consecutive hrs. Ten subjects bicycled, 20 subjects controlled EEG activity during bedrest, and 10 subjects napped. Eight measures of addition, auditory vigilance, mood, and oral temperature were obtained. The Bedrest group showed significant impairment on all eight measures, and thus, gave no support to the forced-rest theory of sleep function. The Exercise group was worse than the Nap and Bedrest groups for all measures. In spite of fragmented, reduced sleep (about 3.7 hrs per 24 hrs), the Nap group had no impairment on six of the measures. The results suggest that exercise increases the impairment due to sleep loss, and naps reduce or remove this impairment. Bedrest is not a substitute for sleep.

755 Lubin, A., Johnson, L. C., & Austin, M. T. Discrimination among states of consciousness using EEG spectra. Psychophysiology, 1969, 6, 122-132.

EEG recordings were made during waking (W) and the five sleep stages (REM, 1, 2, 3, and 4) on thirteen young adult males. For each stage, one-minute sections of the parietal EEG trace were digitized and subjected to Fourier analysis. The resulting spectral intensities were divided into five frequency bands; delta, theta, alpha, sigma, and beta.

Linear discriminators for all six stages were calculated using stepwise multiple regression. The overall percent agreement with visual scoring was very poor, ranging from zero for stage 3 to 91% for stage 4. Linear discrimination between pairs of stages yielded slightly better results, but stages 1 and REM were indistinguishable.

Delta is the best overall discriminator, increasing significantly through stages W, 1, 2, 3, and 4. Sigma is unique to sleep and is highest for stage 2. Theta is unimportant and beta plays no role at all.

Spectral analysis of the parietal EEG lead is not sufficient to differentiate among the six states of consciousness studied here. The use of detectors for such phasic events as eye movement and K-complexes might aid sleep stage discrimination considerably.

756 Lubin, A., Moses, J. M., Johnson, L. C., & Naitoh, P. The recuperative effects of REM sleep and stage 4 sleep on human performance after complete sleep loss: Experiment 1. Psychophysiology, 1974, 11, 133-146.

Twelve young (17-21 yrs) male Navy recruits volunteered for a sleep loss study. After 4 baseline days, the Ss were completely deprived of sleep for 2 days and nights. Next followed an experimental phase of 2 days and nights after which all Ss received 2 nights of uninterrupted sleep.

During the experimental phase, the 4 Ss in the REM-deprived group were aroused whenever they showed signs of REM sleep. The 4 Ss of the stage 4-deprived group were aroused whenever they showed signs of entering stage 4 sleep, and the 4 Ss of the Control group had uninterrupted sleep.

All tests (speed and accuracy of addition, speed and accuracy of self-paced vigilance, errors of omission in experimenter paced vigilance, immediate recall of word lists, and mood) showed significant impairment after the first night of complete sleep loss. But during the experimental (sleep-stage-deprivation) and recovery phases, all three groups showed equal rates of recovery.

Depriving the S of stage REM or stage 4 during recovery sleep does not affect the recuperation rate. Frequent arousals (50- 100 per night) also do not impair recovery. The amount of sleep is probably more important than the kind of sleep.

- 757** Luby, E. D., Frohman, C. E., Grisell, J. L., Lenzo, J. E., & Gottlieb, J. S. Sleep deprivation: Effects on behavior, thinking, motor performance, and biological energy transfer systems. Psychosomatic Medicine, 1960, 22, 182-192.

The effect of sleep deprivation on behavior, thinking, motor performance, and biological energy transfer systems was studied in a single subject who remained awake without drugs for 220 hours.

Behavioral changes included irritability, paranoid thinking, expansiveness, grandiosity, hypnagogic states, visual hallucinations, and episodic rage.

Deficits in thinking and visual-motor performance occurred cyclically across days of wakefulness, with gradual deterioration finally resulting in virtual untestability on the ninth day.

Energy transfer systems responded to sleep deprivation as a stressor with a marked increase in the specific activities of ATP, AMP, and F-1,6-P; this was evident on the fourth day. For the first time in our laboratories, radioactive phosphorus was observed in AMP, a reflection of increased synthesis of this substance from adenine, ribose-1-phosphate, and phosphate. This emergency energy mobilization began to fail by the seventh day, when the specific activities of all the adenylic phosphates fell appreciably.

- 758** Lucaccini, L. F. Vigilance and irrelevant stimulation: A test of the arousal hypothesis (Doctoral dissertation, University of California, Los Angeles, 1968). Dissertation Abstracts, 1969, 29, 3523B-3524B. (University microfilms No. 69-5332)

Three experiments were performed. Two experiments (Studies 1 and 2) were preliminary studies designed to test the effectiveness of procedures used in the main experiment (Study 3). In Study 1 subjects performed a 40-min simple visual vigilance task. Twenty subjects listened to varied task-irrelevant auditory stimulation (music) during the monitoring session while 20 subjects heard equivalent intensity, nonvarying, broad-band noise. Performance was significantly higher with music than noise and a significant performance decrement occurred under noise only.

Study 2 was identical to Study 1 except that a complex visual vigilance task was used. Performance under music was superior to that under noise during the second half of the session. Group-based performance measures did not reveal decrements in detection efficiency; however, a significantly greater number of subjects showed performance decrement under noise than music.

In the main experiment, Study 3, physiological correlates of vigilance performance were sought. Twenty subjects served in four 60-min sessions in which performance and physiological measures were recorded concurrently. Physiological measures taken were palmar skin conductance (basal level), respiration rate, heart rate, and muscle tension of the right forearm flexor group. Each subject experienced all four of the task-background combinations of Studies 1 and 2. In general, group-based measures of performance and physiological activity were insensitive to the experimental manipulations. Nevertheless, significant, positive correlations were found between detection efficiency and two physiological measures of arousal, basal skin conductance and forearm muscle tension. The correlations, computed within subjects, were significant for both tasks.

The results of Studies 1 and 2 support the notion that sustained stimulus change is a critical determinant of effective stimulus variety. The significant intraindividual correlations found between performance efficiency and physiological activity in Study 3 provide theoretical support for the position that vigilance performance is linked to the level of observer arousal. The low magnitude of the correlations obtained indicates that these measures, in their present form, have limited practical value. Suggestions are made for further research to increase their predictive power.

- 780 Luczak, H. The use of simulators for testing individual mental working capacity. Ergonomics, 1971, 14, 651-660.

Simulation in ergonomics research is defined as purposeful experimentation on models of work situations. The operator, who determines the functional relationship between stress and strain, is interpreted as the unit of individual mental working capacity. A theory of mental stress, built up with concepts from formal logic, systems theory and information theory, is presented. Three simulators of mental stress, constructed from the theoretical concept, are introduced. A measurement of strain with cardiac parameters is mentioned. Several concepts for the evaluation of individual mental working capacity are discussed.

- 780 Luczak, H., & Laurig, W. An analysis of heart rate variability. Ergonomics, 1973, 16, 85-97.

Proceeding from a formal definition of heart rate variability, some mathematical and statistical techniques from sampling statistics and time series analysis for the analytical evaluation of heart rate variability for ergonomic purposes are presented and compared. The concept of sampling statistics gives a measure of heart rate variability, arrived at by combining two measures, which were chosen according to a definite criterion. The applicability of this measure is discussed; especially with respect to serial correlation influences when using statistical tests. The two main methods of spectral analysis—the calculation of the transformed autocovariance function and of harmonic analysis—are presented. The influences of interpolations, algorithms and physiological effects are discussed. A possible measure of heart rate variability, calculated by spectral estimates, is proposed and some results are given.

- 781 Lugovoy, L. A. Sutochnaia periodika chastoty dykhaniia u cheloveka v eksperimentakh s invertirovaniem rezhima truda i oldykha. [Diurnal periodicity of the respiration rate of men during inverted work-rest cycles.] Kosmicheskaja Biologija i Meditsina, 1972, 6, 75-81.

Experiments were carried out on eight male test subjects who lived for 25 to 45 days in isolated chambers with controlled comfortable atmospheres. An exposure to an inverted (a 12-hour shift) work-rest cycle; the effect of ecologic time-givers being excluded, brought about a gradual rearrangement of the diurnal rhythm of the respiration rate in accordance with the altered cycle. A study of different patterns of an adjustment to a new cycle indicated that the rearrangement developed the faster, the greater being the sleep deficit during the transition. Endogenous and exogenous components of the diurnal rhythm of the respiration rate were revealed. The endogenous component, which is related to the biological clock of the organism is characterized by inertia, a relatively low rate of rearrangement, whereas the exogenous component depends on diurnal variations of psycho-physiological activity of man and changes simultaneously with alterations in his work-rest cycles. The difference between the above two components of the diurnal rhythm has been noted in other physiological parameters as well.

- 762 Luschei, E., Saslow, C., & Glickstein, M. Muscle potentials in reaction time. Experimental Neurology, 1967, 18, 429-442.

Seven human and 4 monkey Ss performed a reaction time task at short latency following sound or light stimuli. EMG potentials were recorded in the responding limb during performance. The EMG latency was analyzed by study of individually recorded traces and computer averaging. Two classes of EMG activity were observed. One class strongly correlated with the response. In human Ss response-correlated activation of biceps occurred 80 msec after an auditory stimulus and 125 msec after a light stimulus. Slightly longer latencies were recorded for response-correlated activity in monkeys. The 2nd class was unexpected. Early EMG activity was seen in responding muscles much before the response-correlated potentials and appeared to be more closely linked to the sensory stimuli than to the response. Such early potentials were seen at latencies as brief as 25-50 msec after the stimulus in the arms of monkey Ss and were observed in extensor digitorum communis of 1 human S when intramuscular recording electrodes were used.

- 763 Lynn, R. Attention, arousal and the orientation reaction. Oxford: Pergamon Press, 1966.

This book reviews the literature pertaining to the orientation reaction and covers the following topics:

The orientation reaction.

Physiological mechanisms in the orientation reaction.

The habituation of the orientation reaction.

Neurological models for habituation of the orientation reaction.

Conditioned orientation reactions and the role of the orientation reaction in conditioning.

The orientation reaction in ontogenetic and phylogenetic development.

The orientation reaction in the measurement of individual differences.

M

- 764 Mac Kay, D. M., Evans, E. F., Hammond, P., Jeffreys, D. A., & Regan, D. Evoked brain potentials as indicators of sensory information processing. Neurosciences Research Program Bulletin, 1968, 7, 184-277.

The following topics are discussed in this report:

1. Physiological correlates of evoked potentials (EP).
2. Characteristics of visual and auditory EP's.
3. Evoked potentials and psychophysics.
4. Anatomical distribution of evoked potentials.
5. Physiological stocktaking.

- 765 MacKay, D. M., & Jeffreys, D. A. Visually evoked potentials and visual perception in man. In R. Jung, (Ed.), Handbook of sensory physiology: Central processing of visual information, Part B, (Vol. 7/3). New York: Springer-Verlag, 1973.

The possibility of recording brain activity through the intact scalp has obvious perennial attractions for the investigator of human perception. To the psychologist, the very dependence of EP's on psychological factors which bedevils their physiological interpretation could be of great practical usefulness. Can the sensory physiologist hope to gain information of comparable value? The samples of evidence we have surveyed suggest that he can, provided that experiments are carefully planned to avoid certain pitfalls and to give necessary discriminative power. In such areas as binocular interaction and fusion, and pattern and colour vision, EP methods have already supplied information of considerable physiological interest, and their power may be expected to increase as the principles of interpretation become clearer, illuminated by collateral studies in lower animals and aided by more sensitive on-line computing methods of detecting correlations and trends.

Since the direct calculation of source distributions from scalp potentials is likely to be forever impracticable, the physiological value of the method must depend on our ability to narrow the range of possible alternative sources to manageable dimensions. In this connection current developments in functional neuroanatomy promise to be of particular importance, and clinical as well as experimental findings should have a vital part to play. With full utilization of such clues in a hypothetico-deductive manner, even the "frosted glass" of evoked potential techniques may be expected to reveal much that can be learned in no other way about the human visual system.

766 MacKay, D. M., & Rietveld, W. J. Electroencephalogram potentials evoked by accelerated visual motion. Nature, 1968, 217, 677-678.

The EPs recorded in these experiments seem clearly related to acceleration of a central portion of the retinal image. Their magnitude reflects both the change in velocity and the number, but not the direction, of accelerated contours.

They might therefore be parsimoniously interpreted as non-vectorial signs of the disturbance of the retinal population by the displacement of contours from stimulated to unstimulated areas; but it also appears that this disturbance is greatly increased (at least with small numbers of moving lines) by the proximity of other lines to serve as landmarks. The nature of the technique prevented the recording of signals indicative of steady velocity, so it remains doubtful whether these EPs reflect the activity of velocity-sensitive units in the visual cortex. It seems likely, however, that they may have a similar origin to the EPs recorded by Gaarder et al. following saccadic eye movement, and to the EPs for pattern reversal recently described which can be regarded as a limiting case for infinite image velocity.

767 Mackie, R. R. Introduction. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

1. Fifteen years ago there was practically no mention of the physiological correlates of vigilance performance other than a few remarks concerning muscle-action potentials, although in one interesting theoretical discussion Buckner concluded, "If the arousal hypothesis is going to be useful in explaining vigilance behavior, it is fairly obvious that we need an independent measure of arousal. I suppose a physiological measure is the most likely candidate". There was no reference to the many now commonly measured correlates such as EEG, cortical evoked potentials, heart rate, heart rate variability, GSR, CFF, and biochemical measures such as the catecholamines, all of which the reader will find used liberally in the studies reported in this volume.

2. There was little mention of research on vigilance as a function of extended or repeated periods of work, of how vigilance is affected by various work/rest cycles, or of the possible effects of circadian rhythms on vigilance behavior. Several very important papers in this volume are devoted to these topics.

3. There was only one short paper that concerned itself with the theory of signal detection; the application of TSD to vigilance behavior was indeed a novelty. Today, its use is commonplace although it is fair to say that its applications and limitations are still the subject of considerable discussion.

4. Finally, in the earlier symposium there was considerably more debate about defining the scope of phenomena that properly fell within the definition of vigilance behavior. McGrath proposed a number of definitional criteria which stimulated considerable discussion and little agreement. Some of them were (a) a vigilance task must involve the perception and report of a change in the operating environment; (b) the signal (stimulus) to be detected must be specified; (c) when the signal is a stimulus not requiring an orientation response, its intensity should be close to the observer's detection threshold; (d) the signals should occur infrequently; (e) they should occur at random time intervals; and (f) the ratio of nonsignificant to significant signals should be high.

Many, if not most, of the papers presented at this symposium would fail to meet one or more of these criteria. Thus, while it seems likely that most vigilance researchers today would find this list overly restrictive, it is not clear that we have yet reached a satisfactory statement of what vigilance research does or does not encompass, although I believe this symposium made some further progress toward that objective.

- 768 Mackie, R. R., & O'Hanlon, J. F. A study of the combined effects of extended driving and heat stress on driver arousal and performance. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

An experiment was conducted on the highway to identify the effects of hot, humid environments on driver performance, subjective state, and various physiological responses believed to reflect arousal or stress. Each driver drove a standard sized American passenger car over a 360-mile (600 km) route, once under comfortable conditions and once under heat stress.

Under heat stress, the drivers had a systematically higher heart rate, greater heart rate variability, less energy in the higher frequency EEG bands, and produced fewer 17-hydroxycorticosteroids than they did in the comfortable driving environment. They rated themselves more alert early in the trip when in the hot environment but significantly less alert near the trip's end; they also rated themselves as notably more fatigued during the second half of the trip when in the hot environment. Finally, their performance was systematically poorer in the hot environment as reflected by a greater number of relatively large steering adjustments, the commission of a greater number of technical errors, and an increased tendency to inadvertently drift out of the appropriate lane of traffic.

- 769 Mackie, R. R., O'Hanlon, J. F., & McCauley, M. A study of heat, noise, and vibration in relation to driver performance and physiological status (Tech. Rep. 1735). Goleta, Calif.: Human Factors Research, Inc., 1974.

Three experimental studies were conducted on the highway to determine the effects of heat, noise, and vibration on the driving performance, subjective feelings of alertness and fatigue, and physiological signs of stress among drivers of passenger cars and trucks. Heat stress was shown to significantly affect both driver performance and various indices of central nervous system arousal felt to be important to driving safety. Different levels of noise and vibration stress, typical of many trucking operations, did not differentially affect driver performance. However, it was shown that the noise stress was sufficient to induce permanent hearing loss in some drivers and that the amount of vibration stress, unless compensated for by properly designed seats, was borderline with respect to current standards for "fatigue-decreased proficiency." A review of pertinent literature on stress and human reactions to it is included.

- 770 Mackworth, J. F. Vigilance, arousal, and habituation. Psychological Review, 1968, 75, 308-322.

Discusses decrements in performance in vigilance tasks in terms of habituation of the neural responses to the background events of the tasks. Habituation of the arousal response leads to an increase in variance and amplitude of the spontaneous neural rhythms; this increase in neural noise may result in a decrease in sensitivity to the signal events. Habituation of the evoked responses to both signal and nonsignal events of the task produces a decrease in amplitude and increase in latency of the evoked response, which may cause the decreases in correct and false detections found in many vigilance tasks. Sensitivity may increase as the neural evoked response to the nonsignal events decreases, thus counteracting the effect of the decrease in the arousal response.

- 771 Mackworth, J. F. Vigilance and attention: A signal detection approach. Baltimore, Md.: Penguin Books, 1970.

Minor sections of this work deal with physiological correlates of performance.

- 772 Mackworth, J. F. Vigilance and habituation: A neuropsychological approach. Baltimore, Md.: Penguin Books, 1970.

While there is a good deal of evidence that there is a decrease in arousal during a monotonous task, and some evidence that this decrease is correlated with the decrement in performance, it cannot be said that the hypothesis is proved. This conclusion is even more applicable to changes in the evoked potential, which at present have been examined in two experiments with regard to signal detection, and a few more with regard to the changes in latency. It is hoped that this summary of the available material will suggest the necessary experiments, with the important controls.

It is not possible to separate the various hypotheses that have been put forward to account for the vigilance decrement. The subject's estimate of the probability that an event will be a signal will affect his observing responses, the amplitude of the evoked potential, the level of the arousal response, and the degree of inhibition of physiological responses, as well as the probability that he will answer yes or no to a particular level of observed event. Thus, it would seem that at this time it is better to determine as widely as possible the various concomitant changes in the physiological and psychological responses of the subject, rather than trying to distinguish between one theory and another.

- 773 Mackworth, N. H., Kaplan, I. T., & Metlay, W. Eye movements during vigilance. Perceptual and Motor Skills, 1964, 18, 397-402.

This study concerns eye movements recorded during a vigilance situation. Evidence was obtained on where people looked when they were watching for signals, which were 0.5-sec pauses in the motion of a slowly revolving pointer. The following results were obtained: (1) Detection probability for two dials was approximately half the detection rate for one dial. (2) Analysis of eye-movement records showed that in the one-dial situation every missed signal was fixated without being recognized. (3) In the two-dial condition, signals were not only either fixated or unfixated, but some were fixated for part of their duration. Approximately one-third of the signals fell into each fixation category. (4) In contrast to the one-dial condition, the largest proportion of unreported signals for two dials were not fixated at all. Nearly as many unreported signals were partially fixated. About one-quarter of the unreported signals were fixated for their full duration. (5) Individual Ss differed with respect to the time they paused on one dial before shifting to the other. Those who shifted more frequently detected more signals.

- 774** Maclean, V., Ohman, A., & Lader, M. Effects of attention, activation and stimulus regularity on short-term 'habituation' of the averaged evoked response. Biological Psychology, 1975, 3, 57-69.

Three studies are reported in which the effects of direction of attention, level of activation and regularity of stimulation on the rate of amplitude decrement over time of the auditory evoked vertex responses in humans were examined. Short-term, stimulus-by-stimulus changes were assessed by averaging across trains each of 10 click stimuli. The effect of directing attention towards the stimuli was to enhance the $N_1 - P_2$ component, but usually only under conditions of high activation and with irregular stimulus presentation. Habituation rate was hardly affected by the experimental manipulations. The most clear-cut relationship between psychological influences and the AER was that between level of activation and the $P_2 - N_2$ component.

- 775** MacNeilage, P. F. Changes in electroencephalogram and other physiological measures during serial mental performance. Psychophysiology, 1966, 2, 344-353.

Can EEG amplitude changes be related to specific moment-to-moment changes in task performance? To what extent are EEG changes related to changes in other indices of activation? Physiological responses were recorded from 20 Ss during 12 alternately fast and slow trials of a paced auditory serial addition task and 3 writing trials involving similar responses. Trial-by-trial results showed that EEG amplitude usually tended to covary with other physiological functions in a manner expected from activation theory. All physiological levels decreased during the session but became increasingly sensitive to differences in task difficulty. Within trials there was some concordance between alpha amplitude levels and other physiological levels, but exceptions to this trend and further analysis of palmar conductance patterns suggested that consideration of differential sensitivities of the individual measures to behavioral events might be more profitable than an activation theory approach. The only relation between EEG changes and specific behavioral events was the tendency for alpha and beta to block during motor responses.

- 776** MacNeilage, P. F. EEG amplitude changes during different cognitive processes involving similar stimuli and responses. Psychophysiology, 1966, 2, 280-286.

In order to investigate the effects on EEG amplitude of cognitive processes, as distinct from direct effects of sensory stimulation and motor response, Ss were given 3 different tasks in which the stimuli were always similar sets of spoken numbers and the responses were always written numbers. In response to 61 regularly occurring, randomly ordered, single-digit numbers, 7 Ss wrote, on successive trials, (1) the sum of every 4 consecutive numbers, (2) every 4th number, and (3) every 7 and 9 heard. Since the physical stimuli were the same and the movements of response were similar for the 3 tasks, intertask pattern differences in EEG alpha and beta amplitude would presumably be due to differences in the cognitive processes required in the tasks. No differences due to cognitive factors were found. All short-term variations in both alpha and beta appeared related to widespread effects of response and preparation for response. Preresponse effects seemed related to motor set which was distinguished from attentional factors. The results suggest the necessity for a greater emphasis on motor effects in EEG studies.

- 777 Malmö, R. B. Activation: A neuro-psychological dimension. Psychological Review, 1959, 66, 367-386.

The neuropsychological dimension of activation may be briefly described as follows. The continuum extending from deep sleep at the low activation end to "excited" states at the high activation end is a function of the amount of cortical bombardment by the ARAS, such that the greater the cortical bombardment the higher the activation. The shape of the curve relating level of performance to level of activation is that of an inverted U: from low activation up to a point that is optimal for a given performance or function, level of performance rises monotonically with increasing activation level, but past this optimal point the relation becomes nonmonotonic: further increase in activation beyond this point produces a fall in performance level, this fall being directly related to the amount of the increase in level of activation.

- 778 Malmö, R. B. Finger-sweat prints in the differentiation of low and high incentive. Psychophysiology, 1965, 1, 231-240.

The differential effect of incentive on finger sweating compared with the effects on various other physiological measures was investigated in a group of 59 Ss. Finger sweating (FS) appeared slightly superior to palmar conductance (PC) in discriminating between low and high incentive conditions, but heart rate (HR) and muscle potentials appeared to be the best of those discriminators used. Correlations between PC and visual ratings for FS were .65 and .69 for high and low incentive conditions, respectively. There were numerous significant correlations between physiological measures (at relatively low levels), but the 2 FS measures correlated only with PC and with each other. Correlations between physiological and performance measures were also obtained. On the 1 hand HR and EMGs, and on the other PC and FS ratings, differed with respect to the incentive conditions under which significant correlations with performance were obtained. In the main, HR and EMGs showed significant correlations with performance under low, and PC and FS ratings under high incentive. Further evidence for less sweating by dark-skinned Ss compared with light-skinned Ss was reported.

- 779 Malmö, R. B. Physiological gradients and behavior. Psychological Bulletin, 1965, 64, 225-234.

Physiological gradients accompanying mental activity have been found in skeletal-motor and autonomic recordings, commencing with the onset of the behavior sequence and terminating at its conclusion. Experimental evidence is presented indicating that these gradients do not signify increasing activation (or arousal) during the behavioral sequence (e.g., task or period of attentive listening). On the contrary, the EEG evidence clearly indicates that cortical activity remains relatively constant during the sequence when skeletal motor and cardio-respiratory levels show progressive rise. While the gradients therefore appear not to represent increasing motivation during the task, there is strong evidence that the steepness of the gradients is a function of motivational level.

- 700 Malmö, R. B. Cognitive factors in impairment: A neuropsychological study of divided set. Journal of Experimental Psychology, 1966, 71, 184-189.

Forty-two Ss tracking manually but expecting to shift from single (manual) to double (manual and pedal) tracking later in the trial, did not track as well as they did with unified set, expecting to continue with manual tracking all through the trial. This poorer tracking under the condition of divided set was not accompanied, however, by any reliable physiological changes (quantified EEG in 3 frequency bands, action potentials from 5 muscles, heart rate, respiration, and palmar conductance). That this absence of differences in the physiological measures was not due to their insensitivity was demonstrated in a control comparison in which highly significant physiological differences were obtained under conditions in which the performance difference very closely approximated that found in the comparison between divided and unified set. It was concluded that the performance decrement under the condition of divided set was unrelated to change in physiological activation.

- 701 Malmö, R. B., & Belanger, D. Related physiological and behavioral changes: What are their determinants? In S. S. Kety, E. V. Evans & H. I. Williams (Eds.), Sleep and altered states of consciousness. Baltimore, Md.: Williams & Williams, 1967.

This paper will deal with various conditions which are presumed to raise and lower "activation level." As provisional (admittedly imperfect) indicants of activation level, various physiological measures have been used in the experiments to be described. These points will be more clear if we look at the results of a recent experiment by Davies and Krkovic. These investigators recorded performance on an auditory vigilance task and physiological measures over a vigil of 1½ hours. It may reasonably be expected that over a long period such as this, working on a boring task, activation level might decline. Their results were in the expected direction. Level of performance and the physiological measures of activation showed concordant decline over the vigil; and there was close correspondence between the central measure (EEG) and the peripheral physiological measure, skin conductance.

Malmö recently found declining α S levels accompanying performance decrement late in a long session of tracking. In addition to palmar conductance, respiration and heart rate also showed significant decline late in the session. Although mean change in EEG alpha amplitude was in the same direction as that reported by Davies and Krkovic it was very small and statistically insignificant. One of five electromyographic (EMG) placements, that for the left leg, showed significant decrease in muscle tension. It therefore appeared that "peripheral" measures in this study were actually more sensitive than EEG measures in reflecting change in the "tonic" background accompanying the change in performance.

782 Malmö, R. B., & Davis, J. Physiological gradients as indicants of "arousal" in mirror tracing. Canadian Journal of Psychology, 1956, 10, 231-238.

Previous studies from our laboratory and elsewhere suggest that EMG gradients may serve as indicants of drive or "arousal." The present study sought to determine whether similar gradients appear in autonomic functions such as heart rate and blood pressure, and, if so, whether such gradients correlate significantly with EMG gradients and with level of performance.

Forty-three subjects traced a circle viewed in a mirror. There were eight trials, each consisting of four traversals of the circle. Physiological measures recorded were: heart rate, blood pressure, respiration, EMGs from flexor and extensor muscles of the right arm, EMGs from the forehead.

All physiological functions yielded significant gradients; autonomic gradients were significantly correlated with EMG gradients; and the following physiological measures were reliably correlated with speed of performance: EMG (extensor), heart rate, and blood pressure. It was concluded that "arousal-related" gradients are not confined to the skeletal-motor system.

783 Malmö, R. B., & Surwillo, W. W. Sleep deprivation: Changes in performance and physiological indicants of activation. Psychological Monographs: General and Applied, 1960, 74 (15, Whole No. 502).

Three separate 60-hour vigils were held with each of three healthy young male Ss. During each vigil, 10 1-hour recording sessions were held several hours apart. In each session the following measurements were recorded continuously while the S was performing on a tracking task with 5-min trials and 1-min rests: EEG, EMGs from various muscles, respiration, palmar conductance, and heart rate.

Main findings were that in all three Ss, palmar conductance and respiration showed a statistically reliable increase, and 8-12 cps EEG a reliable decrease in amplitude. Heart rate was reliably increased in two of the three Ss, (though reliably decreased in the third S). In addition, each S showed reliably increased muscle tension in only one muscle group (a different one in each S).

On the whole the data strongly supported the conclusion that sleep deprivation had the effect of increasing level of activation. In this respect the present investigation appeared to be different from certain other investigations of sleep deprivation in which conditions were not sufficiently alerting to prevent the Ss from drifting toward sleep. With the overall indication of increasing activation from the peripheral measures, the fall in 8-12 cps EEG was interpreted as also indicative of increasing activation, and not as drift toward sleep.

Under conditions of this investigation, increased muscle tension appeared to be localized in one muscle group rather than generalized over the entire body. In fact, tension in some parts of the body actually fell progressively during the vigil.

It appeared that the special conditions of the tracking sessions were particularly conducive to the appearance of hallucinatory experiences.

- 784** Maltzman, I., & Raskin, D. Effects of individual differences in the orienting reflex on conditioning and complex processes. Journal of Experimental Research in Personality, 1965, 1, 1-16.

Characteristics of the orienting reflex (OR) derived from descriptions of research and theory in the Soviet Union were briefly enumerated. A series of experiments in semantic conditioning, paired-association learning, and "attention" were described. Those Ss with relatively large ORs, as compared with those with relatively small ORs, showed better semantic conditioning of autonomic responses, more readily verbalized the experimental contingencies, were superior in paired-associate learning, and showed greater differential responsivity to signals.

Measures of the OR did not relate to performance in the manner predicted by conceiving of it as a drive condition. It was asserted that effects of the OR correspond to an aspect of what in consciousness-centered psychologies has been described as "attention". It was further asserted that elicitation of an OR constitutes a reinforcing state of affairs. Implications of the concept of OR were indicated for a number of problems involving stimulus change and also for personality theory.

- 785** Mann, H., Poppel, E., & Rutenfranz, J. Untersuchungen zur tagesperiodik der reaktionszeit bei nachtarbeit. III. Wechselbeziehungen zwischen korper Temperatur und reaktionszeit. [Circadian rhythm of reaction time during night work. III. Correlations between body temperature and reaction time.] Internationales Archiv fur Arbeitsmedizin, 1972, 29, 269-284.

Body temperature and reaction time were investigated in 7 subjects during 5 periods of investigation. Simultaneous measurements of both variables were taken every 4 hrs. In each period of investigation body temperature and reaction time showed clear 24 hr-rhythms. During the course of the day reaction time decreased when body temperature increased and vice versa. There was a significant negative correlation of all pairs of data of both variables which were measured at different times of the day. No significant correlation between body temperature and reaction time was obtained when values of the same time of day from several days or average values from successive days were compared.

It is concluded that the negative correlation of body temperature and reaction time is based on the phase-relationship of their circadian rhythms and not on a direct causal connection. Therefore, body temperature cannot be regarded as an indicator of performance.

- 786** Mann, H., Rutenfranz, J., & Aschoff, J. Untersuchungen zur tagesperiodik der reaktionszeit bei nachtarbeit. I. Die phasenlage des positiven scheinwertes und einflusse des schlafs auf die schwingungsbreite. [Circadian rhythm of reaction time during night work. I. Phase of maximum and influences of sleep on range of oscillation.] Internationales Archiv fur Arbeitsmedizin, 1972, 29, 159-174.

Multiple-choice reaction time was investigated in 12 subjects on 31 days during 5 1-week periods on 4-hr intervals. All subjects exhibited diurnal variations of reaction time. The phase-relationship between circadian rhythm of reaction time was constant with regard to the time of day and circadian rhythm of body temperature. Reaction time at 24.00 and 04.00 o'clock was longer than during day time. Reaction time at night additionally was dependent on the duration of the preceding period of sleep or wakefulness. Reaction time was the longer the shorter the preceding time of sleep. Hereby range of oscillation of circadian rhythm of reaction time was modified but the periodicity was not abolished. It is concluded that reaction time represents a measure of a circadian rhythm of performance which is modified but not caused by sleep.

- 787** Marishchuk, V. L., & Kuznetsov, R. V. [Changes in some psychological indices under conditions of fatigue.] (Russ) Voprosy Psikhologii, 1973, 19, 118-121.

Studied changes in a number of psychophysiological indices as a function of fatigue. One group of Ss performed a vigilance task involving motor components of a very high degree of precision. Another group drove automobiles over a difficult stretch of road for 5 days. A large number of psychological tests, measures of motor performance, and physiological measures were taken before, during, and after the task. It is concluded that if a set to perform a certain task is maintained, then under conditions of fatigue, changes in a series of psychological, physiological, and psychophysiological indices occur selectively and in accordance with the set, e.g., more skillful performance is observed on a test immediately after the exercise of the skill than before or after. If a set is absent, only random changes occur. In both cases the range of changes is related to maintaining a balance of the functional possibilities of the organism, i.e., the changes take place within the range of the organism's functional reserves.

- 788** Markhasina, I., & Oranskiy, I. Chastota serdechnol deyatel'nosti i yee periodicheskie sostavlyayushchie u lyudel umstvennogo truda v protsesse proizvodstvennoy deyatel'nosti. [Periodic components of heart rate during mental work.] Activitas Nervosa Superior, 1971, 13, 47-50.

The authors correlate heart rate changes in the course of the working day with the dominance of the sympathetic or parasympathetic system. Under normotonic conditions, the periodicity identified on the autocorrelation curve corresponds with the frequency of 3rd and 4th order waves. A rapid damping of the autocorrelation curve indicates sympathicotony, whereas parasympathicotony is accompanied by a respiratory periodicity.

Measurement by a pulsometer during mental activity will give highly contradictory results which, according to Vinogradov, are related to the character, intensity and duration of the work. A reduction is noted in the pulse rate of adding machine operators, engineers and technicians; an increase is noted in translators and television operators. The present work is a study of the effects of mental work on cardiac cycle duration and its periodicity for people in the engineering profession.

- 789** Marsh, G. R., Poon, L. W., & Thompson, L. W. Some relationships between CNV, P300, and task demands. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

Much of the work in CNV correlates has not emerged from a strong theoretical background. To some extent the same claim could be made for research in P300 correlates. However there exist models from other areas that might be used with some utility. Borrowing from the animal literature, a model has been developed for a brain mechanism controlling attention in the cat and monkey (Gerbrandt et al., 1970; Pribram, 1969, 1970). Specifically, frontal cortical areas were seen to influence the animal toward sampling his environment rapidly but with the sampling restricted to a small area of interest. The temporal-parietal area was seen as an opposite influence, moving the animal toward sampling less often from a widened field from which information was extracted and integrated. The majority of CNV experiments were done using one of the standard RT formats, seemingly biasing Ss into the type of set that was hypothesized to be induced by frontal cortex activity. Thus, if the CNV is a sign of increased activity, one would expect to see CNVs over the frontal areas during the period from the warning signal to the imperative stimulus. Correspondingly, when turned toward more cognitive tasks the parietal areas should show more CNV activity. Our results from the first experiment give partial support to these speculations since greater activity was seen in the parietal area during problem solving than during overtraining. However, changing to an RT task did not elicit the greatest amount of activity from the frontal regions, but rather from Cz. This may be due to the addition of a readiness component in some areas (Otto and Leifer, 1972a, b), or that even the small cognitive component of whether to respond or not might excite some posterior activity.

- 790** Marsh, G. R., & Thompson, L. W. Effect of verbal and non-verbal psychological set on hemispheric asymmetries in the CNV. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 195-200.

The data seem to indicate that a psychological set for verbal or spatial perception can lead to asymmetric bioelectric phenomena, and that the extent of the asymmetry may be predictive of the ensuing perceptual performance.

- 791** Marshall, W. S. III. The effect of an external audio signal on vigilance performance and physiological parameters. Monterey, California: Naval Postgraduate School, April 1970. (NTIS NO. AD-709088)

This research was performed to determine the effect of an external audio signal on visual monitoring performance and any associated changes in physiological parameters of the subjects. The number of correct detections, the number of commissive errors, skin temperature, and skin resistance were recorded throughout the experiment. A two way nested analysis of variance showed that the application of the audio signal did not have a significant effect on the vigilance decrement. The same type of analysis was used to show that the audio signal did not have a significant effect on the physiological parameters measured in the experimental group. Over all experimental groups, skin resistance and skin temperature did change, but the changes were not unique to any given experimental condition. Multiple correlation analyses of the data indicated a high degree of complex interaction between the physiological parameters measured and the vigilance detection decrement.

792 Martin, I. Discriminatory GSRs. Activitas Nervosa Superior, 1965, 7, 217-223.

A study of effect of discrimination schedule on GSR frequency and amplitude and of the effect of informative vs. noninformative instructions. Early in the schedule appeared significant discrimination to positive and negative stimuli. GSR conditioning may refer not to acquisition process, but to the maintenance of higher level of responding to the positive conditioned stimulus.

793 Martin, V. E., & Weber, A. Wirkungen eintonig-repetitiver Tätigkeiten auf das subjektive Befinden und die Flimmer-verschmelzungs-Frequenz. [The effects of monotonous repetitive activities on subjective condition and on the critical fusion frequency.] Zeitschrift für Arbeitswissenschaft, 1976, 30, 183-187.

A brief neurophysiological and psychological presentation of the reasons for monotony is given.

The test series described evaluated the effects of a monotonous repetitive activity on subjective condition and on the critical fusion frequency (CFF) under experimental conditions.

The results from 25 (35) subjects show a significant decrease in CFF (1.7 Hz) and a significant deterioration in the subjective condition in the sense of a decrease in motivation and ability to act.

The decrease in CFF and the change in subjective condition are interpreted as a decrease in activation of the central nervous system.

No significant intra-individual correlation could be found between the decrease in CFF and the deterioration of the subjective condition.

In a control experiment, which used lively tasks, the results showed no change in CFF or subjective condition.

- 794** Martin, W. B., Viglione, S. S., Johnson, L. C., & Naitoh, P. Pattern recognition of EEG to determine level of alertness. Electroencephalography and Clinical Neurophysiology, 1971, 30, 163. (Abstract)

Recognition systems have been designed for a single subject and for composite data taken from 6 subjects. Sleep-stage scoring systems designed on individual subjects and used to classify other recordings from the same subject achieved 81% agreement with manual scoring. Those systems designed on composite data achieved 75% agreement with manual scoring. Awake and stage 4 had the highest per cent of agreement and stages 1 and 3 the lowest.

Detectors for known properties of certain sleep stages such as spindles and K complexes have also been investigated as potential inputs to the pattern recognition system. The spindles are detected by performing a Fourier transform on overlapping 4 sec epochs and comparing the energy in the sigma band with energy in the same band over a 30 sec interval. A peak-and-valley detector to measure the major parameters of the K complex correctly detected 76% of the K complexes over a 4 h period which included all stages of sleep.

The energy in selected frequency bands was computed as an additional indicator of sleep stage. Preliminary findings indicate that delta activity may be the most important input for sleep staging. All night plots of delta activity revealed a cyclic pattern with a smooth build-up of intensity through stages 2, 3, and 4 with an abrupt decline as the subject entered REM sleep. The amplitude of each cycle decreased as sleep progressed. Spindle intensity was highest in stage 2, decreased during stages 3 and 4 and spindles were absent during REM sleep.

- 795** Marum, K. D., Macintyre, J., & Armstrong, R. Heart-rate conditioning, time estimation, and arousal level: Exploratory study. Perceptual and Motor Skills, 1972, 34, 244.

A trend analysis of relative heart-rate measures, (EEG-Basal)/Basal, showed an overall difference in the heart-rate levels over the six periods ($p = .05$). By a method of multiple comparisons the metronome control was associated with the significantly highest heart rate. Although a trend analysis of time judgment data was not significant, the shortest judgment occurred during the metronome-control conditioning, suggesting that higher heart rates are associated with briefer time judgments.

- 796** Maspfuhl, B., & Metz, A. Veränderungen im elektromyogramm bei der beurteilung perzeptiver muster unterschiedlicher schwierigkeit. [Changes in the electromyogram in diagnosing perceptive patterns of differentiated difficulty.] Zeitschrift für Psychologie, 1970, 177, 286-309.

The changes in the production process caused by increasing automation and mechanization result in changing occupational demands on the individual. The proportion of monitoring and controlling activities is increasing at the expense of purely physical demand. The absence of scientific methods for determining the extent of mental activity and of standards for optimum load levels makes it urgent to study mental activity on the basis of objective indicators. The fact that such mental processes can be determined indirectly via physiological phenomena has been demonstrated empirically; the lack of uniformity in the results currently permits no conclusions to be drawn concerning the nature of the relationship. Such basic questions must be answered in systematic research.

Starting with empirically determined relationships, our study was specifically designed for analysis of the relationship between cognitive demands, in the form of assessments of perceptive patterns of differentiated difficulty, and the duration of elevated muscle tone during CNS processing of the stimulus.

- 787 Mathews, A. M., & Lader, M. H. An evaluation of forearm blood flow as a psychophysiological measure. Psychophysiology, 1971, 8, 509-524.

Investigated the usefulness of forearm blood flow (FBF) as a psychophysiological measure by comparing changes occurring during mental tasks in cardiovascular, sudomotor, and EMG measures, using 11 male and 9 female 24-48 yr old Ss. The measures were divided into those clearly physiologically independent and those physiologically related. Analysis of variance results show that FBF, heart rate (HR), and skin conductance fluctuations (SCF) are equally reactive; correlational analysis suggests that a close relationship exists between FBF, HR, and SCF, although correlations fall to near 0 levels when intraindividual correlations were calculated with between task variance extracted. For some experimental purposes HR response may be considered equivalent to FBF response. The relationship between EMG and FBF was more variable, and tends not to support the idea that FBF is an indirect measure of muscle activity. The reliability of FBF in normal subjects at rest was poor, although it improved when measured during a simple task, and is probably stable enough for most experimental purposes.

- 788 Matova, M. A. [Psychological stability of an operator with dual functions.] (In Russian) Voprosy Psikhologii, 1972, 18, 30-37.

Studied performance and physiological correlates of operators under conditions of information overload, response constraints, and auditory noise while simultaneously executing 2 different tasks. Of the 31 Ss tested, 13 failed to perform adequately. Pulse rate differences between the successful and unsuccessful operators were present but were not significant; GSR amplitude differences were significant ($p < .05$), and successful Ss used significantly more visual fixation shifts than did unsuccessful Ss. Subjective evaluation of task difficulty and individual differences in physiological response were related to performance.

- 789 Matsumiya, Y., Tagliasco, V., Lombroso, C. T., & Goodglass, H. Auditory evoked response: Meaningfulness of stimuli and interhemispheric asymmetry. Science, 1972, 175, 790-792.

Interhemispheric asymmetries of different magnitudes were observed in human cortical auditory evoked responses to speech and sound-effect stimuli. The wave with peak asymmetry occurred 100 milliseconds after signal onset. The amount of asymmetry of the amplitude of this wave was related to the meaningfulness to the subject of the auditory stimulus rather than to the mere use of verbal versus nonverbal materials.

- 800 McAdam, D. W. Changes in somato-sensory evoked potentials during the contingent negative variation (CNV). Electroencephalography and Clinical Neurophysiology, 1968, 24, 286. (Abstract)

Except for the first and last components, averaged EP amplitudes were smaller during tones than during intertrials for both groups. There were statistically significant latency shifts for the late EP components (those between 200 and 400 msec), peaks occurring earlier during the CNV than during the intertrial. No such latency shifts were seen in the tone control group. Measurement of background activity upon which the shocks were given showed no significant difference in "EEG activation level" between the two contingencies.

These results are interpreted as providing evidence in support of the hypothesis that the CNV is accompanied by heightened neural excitability.

- 801 McAdam, D. W. The contingent negative variations. In R. F. Thompson & M. M. Patterson (Eds.), Bioelectric recording techniques. New York: Academic Press, 1974.

In the early stages of investigation of contingent negative variations, and even today, there has been a tendency for each group of investigators to adopt and to key on some psychological construct as being of singular importance in determining the development of these potentials. Among the candidates we find "expectancy" from the Bristol group (e.g., Walter et al., 1964), "conation" from the Texas group (e.g., Low, Borda, Frost, & Kellaway, 1966), "motivation" from the Iowa group (e.g., Irwin, Knott, McAdam & Rebert, 1966), and "attention" from the Boston group (e.g., Tecce & Scheff, 1969). While the heuristic value of these beliefs is very high, and while their usefulness as a sort of intuitive shorthand cannot be denied; I submit that this exhausts their list of good qualities; all else is detrimental to the growth of our knowledge. The solution to the problem is, I believe, an observable one. If we will speak about stimuli, responses (including subjective ones), and contingencies, we will be using terms which are precise and which are readily understood by all. And the chips will fall where they should.

- 802 McAdam, D. W., Irwin, D. A., Rebert, C. S., & Knott, J. R. Conative control of the contingent negative variation. Electroencephalography and Clinical Neurophysiology, 1966, 21, 194-195.

Experiments are described in which experimenter-subjects were able to control the amplitude of the contingent negative variation "at will". It is urged that any investigations of the psychological correlates of the CNV which make use of "trained observers" should be interpreted with this possible source of bias in mind, and replicated, where feasible, using unbiased, naive subjects.

- 803 McAdam, D. W., Knott, J. R., & Rebert, C. S. Cortical slow potential changes in man related to interstimulus interval and to pre-trial prediction of interstimulus interval. Psychophysiology, 1969, 5, 349-358.

Two experiments were performed to explore further the relationship between the cortical slow potential change known as the "contingent negative variation" (CNV) and the concept of "expectancy".

In Experiment I, 24 male Ss were presented click pairs, with inter-click intervals of 800, 1600 and 4800 msec (2 blocks of 10 trials each, counterbalanced between Ss for order), and instructed to press a key after the second click. Interval by order by trials analysis of variance showed interval to be the only significant factor: CNVs were lower and RTs longer as interval increased.

In Experiment II, 8 female Ss given 60 pairs of clicks, 30 each with separations of 1200 and 2400 msec, were instructed to respond as in Experiment I, and were asked to make a pretrial prediction of the interval they would next receive. Analysis of variance of RTs showed that Ss responded slower when the interval was other than that predicted. Prediction by reception by subjects analysis of variance of CNV amplitude at the 1200 msec point gave a significant F only for prediction, mean amplitude for short being higher than for long. A similar design applied to CNV amplitudes at both the 1200 and 2400 msec points when Ss received the long interval yielded a significant measurement point by interval predicted interaction; at the 1200 msec point, short predictions were followed by higher CNVs than were long predictions; at 2400 msec, the opposite was found.

These data combine with those already in the literature to indicate that the relationship between "expectancy" and the CNV is far from simple, and that cognitive and motivational factors play a significant role in determining CNV amplitude.

- 804 McAdam, D. W., & Rubin, E. H. Readiness potential, vertex positive wave, contingent negative variation and accuracy of perception. Electroencephalography and Clinical Neurophysiology, 1971, 30, 511-517.

The readiness potential (RP), contingent negative variation (CNV) and vertex positive wave (P302) were recorded in a situation where subjects were asked to present themselves with brief visual stimuli, to attempt to perceive them correctly and subsequently, on cue, to report their perceptions. The results show that the RP preceding the button press leading to the presentation of the stimulus was a reliable index of the neural events associated with subsequent correct or incorrect perception. P302, although showing clear localization at the vertex, was not reliably correlated with the behavioral response. The CNV was shown to be related in this situation to motivation/expectancy/attention factors following the perception and preceding the report. These results are discussed in relation to other work with these phenomena, and the conclusion is drawn that the RP and the CNV reflect common underlying neural processes when both are studied in complex (global) psychological situations.

- 805 McAdam, D. W., & Seales, D. M. Bereitschaftspotential enhancement with increased level of motivation. Electroencephalography and Clinical Neurophysiology, 1969, 27, 73-75.

Bereitschaftspotentials (BSPs) were taken from scalp electrodes overlying the left and right Rolandic areas of eleven human subjects under two conditions, baseline (where responses resulted in no reward) and reward (where "correct" responses resulted in monetary reward). BSP amplitudes were significantly larger under reward than under baseline condition, and were significantly larger over the hemisphere contralateral to the responding hand for both conditions. No interaction between conditions and locations was found. These results are taken as evidence showing some common neural and behavioral substrates for the BSP and the CNV shift known as the Contingent Negative Variation.

- 806 McAdam, D. W., & Whitaker, H. A. Language production: Electroencephalographic localization in the normal human brain. Science, 1971, 172, 499-502.

Slow negative potentials, which are at a maximum over Broca's area in the left hemisphere, were recorded when normal subjects spontaneously produced polysyllabic words. Bilaterally symmetrical potentials were seen with analogous, nonspeech control gestures. These potentials began up to 1 second before word or gesture articulation. These results are the first demonstration of localization of language production in normal human brain.

- 807 McCallum, C. New waves in the brain. New Scientist, 1967, 36, 592-594.

The discovery of a measurable electrical signal from the brain that can be linked to a subjective mental state--apparently an ability to "attend" --has tremendous implications for psychiatry and neurophysiology. It may even one day allow direct mental communication with computers.

- 808 McCallum, C. The contingent negative variation as a cortical sign of attention in man. In C. R. Evans and T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969

The evidence presented, both from patients and non-patients, strongly suggests that the CNV has a relationship to what at the psychological level we are pleased to call attention. It further suggests that changes in amplitude and form of the CNV are closely related to moment-to-moment changes in the focus of what for want of a better expression one must term 'conscious attention'. While such expressions may give rise to shudders and apprehension among many psychologists it has to be faced that concepts such as attention, distraction and concentration stretch our facilities for objective behavioural assessment to the limit. They raise problems with regard both to the quality and the quantity of the experience. At some point in our experiments we are obliged to realize that we are dealing neither with a black-box nor with an animal devoid of speech. Our subjects are human beings capable, in varying degrees, of communicating at least some aspects of their subjective experience. Psychologists tend, by their training, to be reluctant to admit such evidence. They are haunted by visions of the long and hard-fought battles of their distinguished predecessors to eradicate the metaphysical, the introspective and that which is not readily quantifiable. They are understandably anxious not to throw away the victory. Nevertheless, without the admission of some subjective evidence we could not, for example, have learned of some of our subjects' morse code interpretations of the distracting tones, nor of the preoccupation of others with personal problems during the experiments.

- 809 McCallum, W. C. Brain slow potential changes and motor response in a vigilance situation. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

Twenty-seven normal Ss displayed slow potential changes during a vigilance task. When required to respond to the occurrence of three odd numbers in a continuously changing single digit sequence, small negative slow potential shifts followed the occurrence of one odd number and larger shifts followed two odd numbers. Irrelevant clicks introduced during high vigilance conditions and resting control conditions elicited evoked potentials which were not significantly different from one another.

- 810 McCallum, W. C., & Papakostopoulos, D. The CNV and reaction time in situations of increasing complexity. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 179-185.

In a foreperiod reaction time experiment involving successive stages of increasing task complexity no consistent relationship between CNV and RT was found. Correlations between measures of CNV based on amplitude and those based on an integral measurement were consistently of the order of 0.8. A human individual differences factor appeared to be reflected in variations of the CNV amplitude associated with increasing task complexity.

- 811 McCallum, W. C., & Walter, W. G. The differential effects of distraction on the contingent negative variation in normal subjects and psychiatric patients. Electroencephalography and Clinical Neurophysiology, 1968, 24, 593. (Abstract)

The effect of simple distraction on the contingent negative variation (CNV) was studied in 45 chronic neurotic patients, 20 schizophrenic patients and 41 non-patient control subjects, using an automatic averaging technique. Basic CNV levels were established, using paired click and flicker stimuli. Distraction was then introduced in the form of an irregular tone stimulus presented between trials. Both high anxiety neurotic patients and schizophrenics showed a significantly lower basic CNV than the non-patient controls. This difference was considerably accentuated in the distraction condition, the CNV showing a small reduction in amplitude in the non-patient controls and a very marked reduction, amounting in over half of the cases to its complete abolition, in the two patient groups. Significant correlations were found between the amplitude of the CNV in the distraction condition and neuroticism scores as measured by the Middlesex Hospital Questionnaire (Crown and Crisp, Brit. J. Psychiat., 1966, 112: 917), the highest correlations being with the factors of anxiety, obsessionalism and depression. Control experiments involving more varied forms of distraction were carried out on 12 non-patient subjects.

The results are interpreted as indicating a relationship between the CNV and attention. The distraction effects suggest that the CNV may prove a useful diagnostic aid in psychiatry.

- 812 McCallum, W. C., & Walter, W. G. The effects of attention and distraction on the contingent negative variation in normal and neurotic subjects. Electroencephalography and Clinical Neurophysiology, 1968, 25, 319-329.

In Experiment I the effect of simple distraction on the CNV was studied, using an automatic averaging technique, in forty chronic neurotic patients and forty non-patient control subjects. Basic CNV levels were established, the stimuli employed being paired Click and Flicker. Distraction was then introduced in the form of an irregular tone stimulus presented between trials. The high anxiety patient group showed a significantly smaller basic CNV than the non-patient controls. Both groups showed a significant reduction in CNV amplitude in the distracting condition. Reduction in the case of the patients was on the average 80% and in the case of the controls 30%.

Experiment II investigated, in twelve non-patient subjects, the effects on the CNV of more complex forms of distraction and of voluntary concentration. The various forms of distraction were accompanied by reduction in the amplitude of the CNV. The results suggested that the extent of the reduction was related to the degree of attention focused on the distracting stimuli as opposed to the stimuli directly relevant to the experimental task. When a conditional or warning stimulus was itself made intrinsically interesting, and thereby distracting, reduction in amplitude and changes in the latency of the CNV suggested division of attention between the intrinsic and imperative aspects of the stimulus. Concentration resulted in a small increase in the amplitude of the CNV.

- 813 McCanne, T. R., & Sandman, C. A. Instrumental heart rate responses and visual perception: A preliminary study. *Psychophysiology*, 1974, 11, 283-287.

Trained 5 male undergraduates to raise and lower their heart rates (HRs) over a number of operant conditioning sessions. Geometric forms were superimposed upon the conditioned stimuli during the final operant training session. For the conditioning trials, Ss detected significantly more tachistoscopic stimuli during HR deceleration trials than during HR acceleration trials. During extinction trials, there were no differences in tachistoscopic recognition between acceleration and deceleration trials. Results are discussed in terms of J. I. Lacey's hypothesis concerning the instrumental effect of HR change on environmental attention.

- 814 McCarthy, G., & Donchin, E. The effects of temporal and event uncertainty in determining the waveforms of the auditory event related potential (ERP). *Psychophysiology*, 1976, 13, 581-590.

In each of two experimental conditions, subjects were presented with a series of tones, one of two tones (1500 Hz or 1000 Hz) was presented on each trial with a probability respectively of .10 or .90. The subjects counted the rare ($p=.10$) tones, such counted rare tones are normally associated with a large P300 component.

The two conditions differed in that in one the tones were triggered by the subject's button press, in the other the tones were triggered by computer. Schafer and Marcus (1973) reported that all the components of event-related potentials (ERPs) elicited by self-triggered tones were substantially smaller than those elicited by machine-triggered stimuli. Our paradigm allowed a detailed assessment of the effects of self-stimulation on specific ERP components as well as the interaction of temporal with event uncertainty.

Data were analyzed using a Principal Components technique. Both temporal and event uncertainty appeared to augment a negative component of the ERP with approximately 140 msec latency. Such effects, however, were confounded by the presence of slow negative potentials preceding the button press in the self-stimulation conditions. As expected, the P300 component was largest for the ERPs elicited by the rare tones. Temporal uncertainty diminished the amplitude of P300 at central electrode sites. A large slow wave was present following P300; its anterior-posterior distribution was altered by mode of stimulus presentation. It appears that temporal and event uncertainty have distinct effects upon the morphology and distribution of ERP components.

- 815 McCarthy, G., & Donchin, E. Dissociating the components of the CNV in a visual matching task. Psychophysiology, 1977, 14, 95-96. (Abstract)

Ten subjects were required to match two of three line figures exposed for 50 msec. Two types of matches could be made for each slide: matches of functionally related figures, and matches of structural similarity. A tone burst preceded each slide by 1000 msec. In fixed mode matching, the subject performed the same type of match (structural or functional) for all slides in the series. In mixed matching, the frequency of the tone (1000 Hz or 2000 Hz) indicated which type of match the subject was to make. The subject indicated the choice as quickly as possible following the slide. An additional condition of a simple response to a neutral slide was also included.

Ten channels of EEG as well as EOG were recorded and digitized at a rate of 100 samples/sec over a 2560 sec epoch beginning 360 msec prior to the tone. The effects of matching mode (fixed or mixed) and matching type (structural or functional) on the waveform and scalp distribution of the contingent negative variation (CNV) elicited in the tone-slide interval were evaluated using a Principal Components technique.

Two components were extracted from the CNV region: one peaking 400-600 msec after the tone; the other peaking at the slide presentation. The first component altered its anterior-posterior distribution as a function of matching mode. When the tone provided no specific match information, this component exhibited negative polarity maximal at Fz. When the tone provided task relevant information, this component became positive in the parietals while remaining negative frontally. The alterations in this component greatly changed the apparent CNV distribution. Ramp shaped and rectangular CNVs could be simultaneously obtained from different electrode sites.

The second component exhibited maximal negativity centrally. Interhemispheric asymmetries were noted for this component in all experimental conditions (in all cases, left hemisphere more negative than right hemisphere). However, the degree of asymmetry was largest for the mixed matching condition.

- 816 McDonald, R. D. Slow fronto-occipital potentials, mental category, and laboratory performance (HumRRO Professional Paper 17-69). Alexandria, Va.: Human Resources Research Office, May 1969.

Laboratory performance tasks were individually administered to 120 pre-basic trainees selected on the basis of AFQT classification. Concurrent with performance on some of these tasks, slow biopotentials (mv) were recorded from the frontal and occipital emissary vein distributions on the midline scalp and were displayed on a Type R Dynograph. On other tasks, biopotentials were not recorded, and each trainee did not take every task. Assignment of trainees to a particular task was representative with respect to Mental Category. Tasks included paper and pencil questionnaires, visual search, simple serial reaction time, visual vigilance, perceived illusion change, and simple arithmetic reasoning.

Variations in this biopotential were compared with performance changes during some of these tasks to determine the possible significance of this measure as a physiological correlate of alertness. These biopotentials were also examined independently with respect to their ability to predict performance on some of the above tasks.

No consistent relationships were found between the fronto-occipital potential, in terms of absolute voltage or polarity drift (positive or negative shifts), and ongoing performance during the vigilance task, the illusion change task, the reaction time task, or the arithmetic reasoning task. This potential, at least as measured in this study, is not useful as an index of attentiveness-variation during ongoing performance. Comparable task performance occurred between trainees selected on the basis of extreme fronto-occipital potential differences. These data indicate that this potential has no predictive value in terms of task performance.

- 817 McHugh, W. B., Brictson, C. A. & Naitoh, P. Emotional and biochemical effects of high work-load. In A. N. Nicholson (Ed.), Simulation and study of high workload operations. AGARD Conference Proceedings, No. 146, 1974. (Available from: National Aeronautics Space Administration, Langley Field Virginia 23365; Attn: Report Distribution and Storage Unit)

A preliminary longitudinal multifactorial study of the interrelationships of biochemical, mood, biographical factors and landing performance under high work load conditions has been carried out with U. S. Naval Aviators. Levels of serum cholesterol, serum uric acid, blood lactate, pyruvate, and mood assessments were made during periods of non-flying activity and during periods of increased cumulative work load. Uric acid values fell during moderate cumulative work load, and cholesterol values fell during high cumulative work load. Increased variability of pyruvate and lactate were noted with increased cumulative work load. Increased cumulative work load did not affect emotions or performance but altered mood association patterns and altered the relationships of mood and performance. Experience was correlated with performance under zero cumulative work load conditions. Emotion correlated with performance under high cumulative work load conditions.

- 818 McKee, G., Humphrey, B., & McAdam, D. W. Scaled lateralization of alpha activity during linguistic and musical tasks. Psychophysiology, 1973, 10, 441-443.

Studied relative bilateral alpha activity over temporal-parietal sites in 4 normal undergraduates while they were engaged in either a musical task or 1 of 3 linguistic tasks of varying difficulty. Left-right alpha ratios were highest for the musical task and tended to decrease progressively with increasingly difficult linguistic tasks.

- 819 McNulty, J. A., & Noseworthy, W. J. Physiological response specificity, arousal, and task performance. Perceptual & Motor Skills, 1966, 23, 987-996.

Two groups of 25 Ss were given 3 different tasks to perform: (1) a verbal paired-associate learning task, (2) a pursuit rotor task, and (3) a finger dexterity task. One group performed the tasks under high arousal (electric shock) and the other under low arousal (no shock). A number of physiological measures, including muscle tension, heart rate, skin resistance, and blood pressure, were also recorded. On the basis of these physiological measures, each S was classified according to the physiological function in which he showed the greatest relative activity over the 3 tasks. This was done in order to determine whether S's most active physiological index was related in any systematic way to his task performance. Results showed that neither arousal condition nor most active index was related to performance on the verbal learning task. On the 2 motor tasks, however, performance was, in general, better under high than under low arousal, and, in addition, varied with S's most active physiological index. It appears, therefore, that S's typical mode of channeling activation may influence his performance on certain tasks.

- 820** McRuer, D. T., Magdaleno, R. E., & Moore, G. P. A neuromuscular actuation system model. IEEE Transactions on Man-Machine Systems, 1968, MMS-9, 61-71.

Reviews physiological and human-operator data and presents a simple neuromuscular actuation system model. Data indicate that simple linear models can describe the basic behavior of the muscle spindle and the input-output of the muscle in tracking tasks. Two key developments are presented: (a) the variation in system parameters as a function of average muscle tension or operating point, and (b) the role of the muscle spindle both as an equalization element and in its effects on muscle tone or average tension. The neuromuscular model suggested is one in which muscle spindles provide 4 functions in 1 entity: (a) the feedback of limb position; (b) lead/lag series equalization; (c) the source of at least 1 command signal to the system; and (d) a signal for adjustment of the spindle gain, equalization, and steady-state spindle output which produces the average muscle tension. The phase lag of the neuromuscular system's closed-loop describing function exhibits a variation with average muscle tension that is strikingly similar to that observed for the overall human operator in complex tracking tasks. The pertinent human-operator-describing function data include the covariation of high- and low-frequency phase data and the variation of high-frequency phase with set tension changes interpreted from force disturbance experiments.

- 821** Melton, C. E., & Fiorica, V. Physiological responses of low-time private pilots to cross-country flying (FAA-AM-71-23). Washington, D. C.: Office of Aviation Medicine, April 1971. (NTIS No. AD-728317)

Various physiological, biochemical, and psychophysiological measurements were made on low-time private pilots who each flew three cross-country flights. The round-trip flights were 320, 520, and 960 NM in length. Heart rate was recorded continuously throughout the flights. Urine, collected for the 24-hr period surrounding the flights, was differentially analyzed for epinephrine and norepinephrine. None of the measured parameters changed in proportion to the length of the flights; however, the level of stress was high when compared to other types of flying activities. The total stress of such flights must, therefore, be considered to be in direct proportion to the length of the flights.

- 822** Melton, C. E., Jr., McKenzie, J. M., Polis, B. D., Funkhouser, G. E., & Iampietro, P. F. Physiological responses in air traffic control personnel: O'Hare Tower (FAA-AM-71-2). Washington, D. C.: Office of Aviation Medicine, January 1971. (DDC No. AD-723 465)

Physiological and biochemical measurements were made on 22 air traffic controllers at O'Hare tower during five days of the heavy traffic evening shift (1600-2400) and five days of the light traffic morning shift (0000-0800). Pulse rates were higher on the evening shift than on the morning shift. Converging approaching traffic was more excitatory than departing diverging traffic on the evening shift; there was no differential response on the morning shift. Galvanic skin response indicated that adaptation to the morning shift was incomplete in five days. Fibrinogen levels in controllers' blood was not elevated above the expected level for their age group. Controllers had a higher total plasma phospholipid concentration than populations of normal people, schizophrenics and combat pilots. Phosphatidyl glycerol was significantly higher in controllers' plasma than in the normal population but less than in the combat and schizophrenic populations. Findings from urine analyses that are reported separately by Hale, et al., have been summarized in this report. Urine chemistry shows that catecholamine excretion is related to the number of aircraft operations. Corticoid excretion rises late in the morning shift and recovery from morning shift work is incomplete during the off-duty rest period.

- 823 Melton, C. E., Wicks, M., Saldivar, J. T., Jr., Morgan, J., & Vance, F. P. Physiological studies on air tanker pilots flying forest fire retardant missions (AM 68-26). Federal Aviation Administration, Office of Aviation Medicine, October 1968 (NTIS No. AD690090)

Pre-flight and post-flight studies were carried out on five air tanker pilots; in-flight studies were carried out on four of these five pilots. Pre- and post-flight studies consisted of a questionnaire and determinations of blood pressure, psychomotor performance and urine chemistry for stress metabolites. In-flight studies consisted of ECG, rectal temperature, cockpit temperature and voice transmissions, all continuously recorded on magnetic tape.

- 824 Menzel, W. Menschliche Tag-Nacht Rythmik und Schichtarbeit. [Human day-night rhythmicity and shift work.] Basle, Stuttgart: Benno Schwabe, 1962.

Part I reviews the many biological variates in man for which 24-hour periodicities can be detected. For the various functions or systems, comprehensive tables summarize the bibliographical references of the pertinent observations and mention the times of day when maximum and minimum levels of a given phenomenon have been found to occur. Three chapters deal successively with the chronological relationships between the various rhythms in the same individual, the persistence of rhythms after removing the regular alternance of the environmental conditions, and the factors which influence the amplitude, the phase relationships or the periodicity of these rhythms. A general, but rather formal theory of the 24 hour rhythms is suggested. Part II gives a critical review of the data available on the various problems connected with night or shift-work. Working efficiency, weekly rest period, loss or disturbance of sleep, subjective complaints and clinical symptoms, frequency of accidents or production disturbances and attitudes of workers are dealt with in successive chapters. Its conclusions are concerned with the practical methods of preventing the unwanted consequences of night or shift-work.

- 825 Meyer-Delius, J. Belastung am Arbeitsplatz durch das Warme Klima. [Thermal burden at the workplace.] Homburg -- Informationen für den Werkarzt, 1972, 21, 42-58.

A mathematical explanation of heat balance and a review of the methods of evaluating heat burden are followed by a detailed study of the physiological causes of reduced attention due to a rise in effective temperature. The author concludes that only persons with good circulation should be employed on work under climatic stress that requires a high degree of vigilance and that haemodynamic examinations should form a part of preventive care for these workers. Consideration of physical work in a hot climate also leads to the conclusion that heat regulation places a considerable burden on the circulation.

- 826** Meyer-Delius, J. Physiological studies of fatigue in activities requiring mental concentration in hot climate, the influence of positioning and sensorial irritation. In N. P. Clarke (Ed.), Performance and biodynamic stresses -- influence of interacting stresses on performance. AGARD Conference Proceedings, No. 101, 1972. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365; Attn: Report Distribution and Storage Unit)

In a hot climate the peripheral vasculatory system is dilated as compared to that in a cooler climate: the peripheral volume pulse is higher, the mean arterial pressure smaller and the heart rate is raised. This regulation device, the peripheral circulation, is influenced by the sympathico-neural impulses through vigilance or noise stimuli in a hot climate, i.e. in the same direction and relative to the initial magnitude of the regulating device, just as in the cooler climate. Vigilance is termed by DEFAYOLLE among others as an increased nervous activity for the perception of information. It became manifest through a noradrenergic reaction: with an elevated peripheral vasotonus and, in the climate in which the studies were performed, namely between 14 and 27° C_{eff}, with a decrease of the heart rate. We consider this to be the response via pressure receptors to the increase of the peripheral circulatory resistance. The respiratory frequency under vigilance rises about 70% above the value at rest and thus indicates a high degree of tension.

Contrary to this we noted a continuous increase of the heart rate in the hot climate which persisted throughout the vigilance activity if same was connected with an elevation of the energy metabolism. The continuous pulse rate increase could not be conditioned on energy since energy metabolism also in the hot climate remained far within the steady state. We interpret the frequency increase as a controlling effect of thermoregulation, caused by a limited heat emission, for in a hot climate with an elevated energetic metabolism under vigilance the peripheral vasotonus remained increased. Consequently the volume pulse was smaller than during the period of non-activity. The continuous increase of the heart rate may be interpreted as a sign of disregulation. It led to a diminishing of vigilance and technically was seen as a prolonged working time which the subjects needed to perform the same number of tasks in a hot climate as compared to the working time in a cooler climate.

- 827** Michaut, G., & Pin, M. C. Effets: sur quelques variables psychophysiologiques de la conduite automobile urbaine. [The effects of city automobile driving on some psychophysiological variables.] Actes du Troisieme Congres de la Societe d'Ergonomie de Langue Francaise, Bruxelles: Presses Universitaires de Bruxelles, 1968, 243-249.

This study related visual choice reaction time, heart rate and a subsidiary task measure of mental load to driving. Heart rate frequency fluctuations did not vary systematically during the three hour test period but exhibited a general tendency to fall.

- 828** Miller, L. H., Veen, W. Van, & Sandman, C. A. Intermodal and intramodal distraction and CNV. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 209-211.

The effects of distraction and attention on the magnitude of the slow potential shifts seen in the i.s.i. of the fixed foreperiod reaction-time paradigm appear to depend upon whether the distraction is intra- or inter-modal. One might explain these effects in terms of "focused" vs. "divided" attentional processes. Intra-modal distraction, for instance, requires focused concentration on a single sensory channel, whereas inter-modal distraction requires the division of attentional processes between two or more separate sensory channels.

Such a formulation would be entirely consonant with McCallum and Walter's (1968) view of the distracting role played by psychological and physiological stimuli in CNV studies employing reaction time procedures. Taking this viewpoint one might anticipate that such "extraneous" variables as bladder tension or preoccupation with personal problems may well provide sufficient inter-modal distraction to inhibit seriously the amplitude of the CNV.

Further examination of the effects of such intra-modal and inter-modal influences on cortical slow potentials would seem to be crucial to the definition of brain-behavior relationships.

- 829** Milosevic, S. Changes in detection measures and skin resistance during an auditory vigilance task. Ergonomics, 1975, 18, 1-8.

Twenty subjects detected slight changes of intensity in a 42dB, 700 Hz signal, presented in an anechoic chamber. According to the degree of confidence in signal perception, the subjects gave responses, within intervals of 4 sec, on a scale consisting of up to three categories of response. During the run, the subjects' skin resistance was measured each 10 min. Results showed that during the run the percentage of correct and false responses decreased for both extreme criteria of response. Sensitivity, d' , remained the same and the criterion index, β , increased as a function of time. Skin resistance also increased progressively. The signal detection theory parameters changed in accordance with Welford's activation hypothesis prediction; activation was closely related to the criterion and strategy of decision-making, and not to sensitivity.

- 830** Mirsky, A. F., & Cardon, P. V., Jr. A comparison of the behavioral and physiological changes accompanying sleep deprivation and chlorpromazine administration in man. Electroencephalography and Clinical Neurophysiology, 1962, 14, 1-10.

1. Eight normal subjects were studied under control conditions, after 66-70 h of sleep deprivation, and after the administration of 200 mg of chlorpromazine. Simultaneous recordings were made of behavior on a test of attention, the EEG, respiration and finger plethysmograph under all conditions.

2. Both sleep deprivation and chlorpromazine produced marked impairment in the performance of the attention test.

3. Errors in performance in the sleep deprivation condition were accompanied by slowing of the EEG, increased respiratory cycle length and increased finger pulse amplitude, as compared with periods when the subjects were performing correctly. Such differences in the physiological accompaniments of performance were far less marked in the chlorpromazine condition.

4. Of the three physiological measures, the EEG appeared to be the least accurate in reflecting variations in alertness.

5. The significance of these findings was discussed in relation to the possible existence of separate, although closely related, mechanisms within the reticular activating system which mediate behavior on the one hand, and the EEG, respiration and peripheral vasomotor tone on the other.

831 Mohler, S. R., Dille, J. R., & Gibbons, H. L. The time zone and circadian rhythms in relation to aircraft occupants taking long-distance flights. American Journal of Public Health, 1968, 58, 1404-1409.

Air travelers traversing four or more time zones experience desynchronization of certain daily biologic rhythms. Until rephasing of the rhythms occurs relative to the solar cycle at the point of destination, some "below par" subjective and psychophysiologic responses result. Information is provided referencing certain of these responses and some suggested means of avoiding "time zone fatigue" are given. Some of the physiological findings are related to performance.

832 Monesi, F., Ravaccia, F. A study of behaviour during a trial of vigilance in non-piloting personnel. In B. O. Hartman (Ed.), Higher mental functioning in operational environments. AGARD Conference Proceedings, No. 181, 1976. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365, Attn: Report Distribution and Storage Unit)

On the topic of planning a laboratory for the assessment of the performance of subjects in operative stress conditions, conventional psychometric as well as neurophysiological methods were employed for data collection, recording and processing.

In the present study, subjects highly experienced in air traffic assessment and decision-making tasks underwent a performance trial involving visual vigilance in a simulated operative environment. Data were collected by administering self-rating scales and recording both reaction times and brain potentials. Statistical analysis of data was performed with parametric and nonparametric tests.

All types of approach proved to be of value in the assessment of performance, although the greater utility of computerized neurophysiological evaluation must be emphasized for an advance in methodology.

833 Monnier, M. Retinal time, retinocortical time, alpha blocking time and motor reaction time. Electroencephalography and Clinical Neurophysiology, 1949, 1, 516-517. (Abstract)

The voluntary motor reaction begins about 110 msec after the flash (motor reaction time), measured on the electromyogram of the thenar muscles.

The alpha blocking time ($215 \text{ ms} \pm 45$) is much longer and varies according to emotional conditions, two facts which suggest that cortico-subcortical reverberating mechanisms may be involved in the production of this "reaction d'arret".

- 834 Moraal, J. The analysis of an inspection task in the steel industry. In C. G. Drury & J. G. Fox (Eds.), Human reliability in quality control, London: Taylor and Francis, 1975.

It may be hypothesized that a relation exists between the number of following movements and the total number of blots, lines, colours etc. to be seen on the sheets, only a minority of which have to be classified as defects. So, the more irregular the surface in appearance the more 'anchor points' for inspection and consequently the more following movements. This hypothesis was supported strongly by the results of the laboratory studies using optical noise patterns. These patterns are very irregular by nature and indeed only following and saccadic movements were found when eye movements were recorded. In this respect one may doubt whether the number of following movements (fixations) may serve as a relevant criterion in assessing inspection accuracy as in fact Shimabukuro et al. used them. Ohtani used a simulated inspection as a criterion measure, namely searching for incomplete rings (Landolt's rings) from a series of complete rings of the same size, again a very irregular field, which may fall short in relevance to the real task. All studies mentioned are in agreement on the duration of fixations: between about 330 to 450 msec. Both Japanese studies regard a line speed of about 300 f.p.m. as becoming critical for optimal inspection: Shimabukuro et al. because the number of following movements decreases in the range of 250 to 300 f.p.m. and Ohtani because this speed is related to missing critical objects (incomplete rings) in the simulated study. Sanders and Hoogenboom also regard 300 f.p.m. as a critical speed because time for inspection given the variability in inspection times, is nearly enough for making at least one fixation (following movement) per sheet (about 300 msec). However, even this will not always be a necessity, for example when defects arrive in batches a peripheral glimpse will suffice. For defects new in appearance, however, a line speed of 300 f.p.m. may be regarded as becoming critical.

- 835 Mordkoff, A. M. Heart rate patterns during the foreperiod of a reaction time trial: The effect of simple versus disjunctive reactions and fixed versus variable foreperiods. Psychophysiology, 1971, 8, 244-245. (Abstract)

The hypothesis of Lacey and Lacey that heart rate deceleration is associated with circumstances that demand attention to the external environment while heart rate acceleration is associated with stimulus rejection was investigated in a study in which both simple and disjunctive reactions were obtained under both constant and variable foreperiod conditions. Compared to the simple reaction time paradigm, disjunctive reactions which involve the presentation of several stimuli are more likely to evoke a sensory attitude in Ss and be accompanied by larger decelerations.

Forty-eight Ss were administered 25 trials under each of the above four conditions. Inspection of the raw data revealed that the same polyphasic deceleratory-acceleratory-deceleratory pattern described by Lacey and Lacey was obtained which was especially prominent during the constant foreperiod conditions. Statistical analysis of various aspects of the response pattern measured during the foreperiod revealed no significant effects related to either initial level of heart rate or magnitude of the early deceleratory "orienting" response. The later acceleratory-deceleratory changes were both significantly affected by both experimental treatments, the responses being greater under the constant foreperiod and disjunctive reaction time conditions. The differences between the simple and disjunctive conditions were accentuated for the acceleratory component under the variable foreperiod conditions.

The data were consistent with Lacey and Lacey's theory of the instrumental role of cardiovascular activity in behavior and specifically that heart rate deceleration is related to conditions which require environmental intake.

- 836 Morgan, A. H., MacDonald, H., & Hilgard, E. R. EEG alpha: Lateral asymmetry related to task, and hypnotizability. Psychophysiology, 1974, 11, 275-282.

Occipital EEG alpha (8-13 Hz) was recorded separately from the right and left hemispheres of 26 right-handed subjects during analytic (verbal and numerical) tasks, spatial (imagery) tasks, a music task, and a hypnotic susceptibility scale. An alpha laterality score was derived by computing the percent difference in the amplitude of alpha in the two hemispheres. This laterality score was significantly different between the analytic and spatial tasks, and between an eyes-open baseline and an eyes-open measurement during hypnotic amnesia. Because the spatial tasks used in this study are considered "easier" than the analytic or music tasks, the role of task difficulty provides some ambiguity in interpretation.

Highly hypnotizable subjects showed significantly more alpha activity (compared to low hypnotizables) in all conditions (both outside hypnosis and within it) except for the eyes-open baseline and the eyes-open measurement following the release of amnesia. No differences were found between low- and high-hypnotizables in the laterality measure. This suggests that the lateral asymmetry of alpha is a function of task rather than of any particular cognitive style that may characterize the hypnotically susceptible. That high hypnotizables showed higher amplitudes of alpha, however, suggests that the overall production of alpha may be positively related to the particular cognitive style that characterizes the person who is able to experience hypnotic phenomena.

- 837 Morrell, L. K. EEG frequency and reaction time - a sequential analysis. Neuropsychologia, 1966, 4, 41-48.

In a prolonged simple vigilance task with normal subjects who were not sleep deprived, trial-to-trial oscillations in EEG background frequency characteristics were noted. These are related to serial changes in reaction time to an aperiodic photic stimulus. Sequential analysis of the background frequency affords prediction of the probability of increased or decreased speed of response on successive trials, as well as an estimation of the likelihood of response failure.

- 838 Morrell, L. K. Some characteristics of stimulus-provoked alpha activity. Electroencephalography and Clinical Neurophysiology, 1966, 21, 552-561.

Two groups of subjects, pre-selected for prominent resting alpha, were studied in order to assess the habituation of EEG reactivity to repeated photic stimuli. In one group, the subjects passively received the signals; in the other they were instructed to respond manually as soon as the signal was detected, and the reaction times were measured. It was found that the EEG background of alpha activity tended to alternate with a lower voltage, more random pattern sometimes including slow waves in both groups. The EEG reactivity against the latter background was that of provocation of alpha activity, whereas against the background alpha rhythm, the reactivity was that of blocking or arrest of alpha. From the point in each record in which these patterns began to alternate, it was found that the alpha provocation response had a higher incidence than the desynchronization response, significantly so only for the group not required to respond. The blocking response was relatively habituated for both groups.

The requirement of a motor response to the photic signal was associated with an increased incidence of the alpha blocking response. Reaction times tended to be higher when alpha provocation occurred.

The hypothesis was advanced that stimulation-provoked alpha activity may be an electrical sign of central inhibitory processes.

- 839** Morrell, L. K., & Morrell, F. Evoked potentials and reaction times: A study of intra-individual variability. Electroencephalography and Clinical Neurophysiology, 1966, 20, 567-575.

Experiments with six normal adults were undertaken in order to study the relationship between intra-individual variability in simple reaction time and electrically evoked potentials.

It was found that the amplitudes of prominent components of the evoked response (both early and late) are correlated with the reaction time to the photic signal. The result was found for occipital, central vertex, and right and left Rolandic regions.

Latency to peak or trough of various wave components had no consistent relationship to RT.

Such factors as selective attention and fluctuations of alertness are discussed as possible determinants of the relationship between RT and amplitude of averaged evoked potentials.

- 840** Morris, C. J., Jr. Electroencephalographic and evoked potential correlates of reaction time and visual discrimination performance (Doctoral dissertation, University of Missouri, Columbia, 1968). Dissertation Abstracts, 1968, 29, 1190B. (University Microfilms No. 68-12, 500)

Electroencephalographic (EEG) and evoked potential correlates of performance on a simple reaction time (SRT) task and a combined choice reaction time (CRT) and visual discrimination (VD) task were examined. Compared with the EEG prior to slow SRT performance, the EEG prior to fast SRT performance was characterized by significantly reduced alpha (8-13 Hz) activity, significantly increased fast (14-40 Hz) activity, and significantly smaller voltage. Wavelength distribution analyses of the EEG prior to CRT and VD performance failed to differentiate high and low performance levels. However, significant voltage differences consistent with those obtained in the SRT analysis were found for both CRT and VD performance.

Significant differences in the amplitudes of the later components of the averaged evoked potential were found between high and low performance levels on the SRT and VD tasks, the amplitudes being larger during fast SRT and correct VD performance as opposed to slow SRT and incorrect VD performance. The latencies of the different components of the evoked potential did not differ significantly among any conditions of the experiment.

Lindsley's (1951, 1952) theory that fast, low-voltage EEG activity is associated with high levels of behavioral arousal, was supported by the results of the SRT analyses and, to a lesser extent, the CRT and VD analyses. The results suggested that the correlation between the EEG and perceptual-motor performance decreases as the complexity of the task increases. The evoked potential analyses supported a similar conclusion and confirmed recent studies which have shown that fluctuations in the evoked potential are associated with changes in behavioral performance.

- 841 Morris, C. J. Electroencephalographic and evoked potential correlates of reaction time and visual discrimination performance. Psychonomic Science, 1971, 23, 193-195.

Found that EEG and evoked cortical potential (ECP) measures of arousal were related to level of performance on RT and visual discrimination experiment with 16 undergraduate and graduate students. ECP measures were more strongly associated with performance on both tasks than any of the EEG measures. However, the very weak association between arousal measures and visual discrimination performance suggested that arousal plays a limited role in the control of complex decision processes.

- 842 Moussong-Kovacs, E. A vigilias neuropszichologiaja. [Neuropsychology of vigilance.] Pszichologiai Tanulmányok, 1966, 9, 417-434.

Presents a model monitor-system operating in a neurosurgical control chamber to connect the psychological and physiological interpretation of vigilance. Physical pathological changes in vigilance are related to the functional systems of CNS and metabolic conditions. Psychological laws of vigilance are reviewed in relation to test and personality variables. Data supporting similarities between psychological and physiological interpretations are pointed out.

- 843 Mulder, G., & Mulder-Hajonides van der Meulen, W. R. E. H. Heart rate variability in a binary choice reaction task: An evaluation of some scoring methods. Acta Psychologica, 1972, 36, 239-251.

Several scoring methods of heart rate variability have been investigated in a binary choice task. It was concluded that in this type of task the number of waves in the cardiogram and the sum of absolute differences between successive R-R intervals divided by the number of waves are the best indicators of the task levels (20, 30, 40, 50 and 60 binary choices per min). A detailed analysis of these scoring methods in different types of information processing tasks is recommended.

- 844 Mulder, G., & Mulder-Hajonides van der Meulen, W. R. E. H. Mental load and the measurement of heart rate variability. Ergonomics, 1973, 16, 69-83.

A number of studies concerning heart rate variability and mental load are reviewed.

It is concluded that in paced choice reaction tasks the number of reversal points in the cardiogram is the most sensitive measure of the load of the task.

This measure was strongly correlated with respiration.

Spectral analysis of heart rate variability revealed the existence of a frequency component at about 0.10 Hz, a respiration frequency and sometimes a task frequency. In a number of tasks the respiration frequency increased, and the amplitude of energy in the lower frequencies decreased (i.e. there was a decrease in heart rate variability).

- 845 Mulholland, T. The electroencephalogram as an experimental tool in the study of internal attention gradients. Transactions of the New York Academy of Sciences, 1962, 24, 664-669.

Although internal attention gradients are familiar psychological processes, they are often difficult to study using only behavioral data. Such gradients may be dramatically evident, as during a "countdown" to a rocket launching. Most everyday events give rise to only moderate levels of attention and less evident attention gradients. However, by using a special electroencephalographic (EEG) technique and appropriate instructions, even such "weak" internalized attention gradients (as occur when a subject is told "to pay attention to the 15th flash" in a temporal series of light flashes) can be evaluated. Such an EEG technique utilizes a feedback loop (connecting stimulus and brain activity) based on the suppression of the alpha brain rhythm (8-13 c.p.s.), which distinguishes it from other loops previously reported.

- 846 Mulholland, T. The concept of attention and the electroencephalographic alpha rhythm. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

These hypothetical relationships have verifiable consequences. Alpha should not occur during fixation, i.e. during a stable triad of accommodation. Temporal variation in the triad of accommodation between stable and unstable states should be correlated with temporal variation of the occipital EEG between activation and alpha states. The familiar habituation of the EEG activation response should have its counterpart in the time series of successive fixations and accommodation responses. Habituation of the oculomotor component of the orienting response should closely parallel the habituation of the EEG component. Aberration of the process controlling the triad of accommodation should be reflected in aberration in the alpha-activation cycle.

Visual perception functions which vary with changes in the fixation accommodation process should vary with the alpha-activation cycle. In general, alpha occurrence should be associated with a decrease of visual accuracy, precision, and efficiency relative to activation. This would not be true for non-visual stimuli.

Variations in visual perception which have been linked to attention may be linked to the oscillations in the limits of the alpha-activation control process rather than being linked to alpha-activation per se. This would be consistent with the idea that fluctuations in attention are linked to the non-random oscillation in successive EEG activation intervals which have been described by Morrell and Morrell and confirmed by Mulholland and Bundzen.

The observations reported earlier which have been accumulating in the EEG literature over the years, as well as the more recent ones described here, pose serious problems for the attention hypothesis. However, they permit no conclusion concerning the origin of the alpha rhythm and might be considered independently of that question. In my view, this is neither a tenable nor useful position. The experimental determination of those brain processes causing the alpha rhythm will permit us both to understand the failure of the attention hypothesis in the interpretation of the occipital alpha rhythm and to explain its relationship to the ocular and oculomotor control systems.

- 847 Mulholland, T. B. Automatic control of visual displays by the attention of the human viewer. In C. M. Williams & J. L. Debes (Eds.), First national conference on visual literacy. New York: Pitman, 1970.

The characteristics of a display could be controlled by attentive looking, which is also under voluntary control. For instance, when alpha was suppressed by attentive looking a series of visuals could be presented at a rapid rate. A much slower rate plus a warning could be given when alpha occurred indicating decreased attentive looking. In the case where there is a continuing inspection of stimuli required, then the rate of presentation of the various objects would be so regulated by attentive looking that the best inspection would occur.

- 848 Mulholland, T. Objective EEG methods for studying covert shifts of visual attention. In F. J. McGugan & R. A. Schoonover (Eds.), The psychophysiology of thinking. New York and London: Academic Press, 1973.

In conclusion, I would like to speculate on some applications of feedback EEG in relation to visual control as I see them. Some of these are already close at hand, others require considerable development (Mulholland, 1970). The following groups of applications are intended as an outline.

Display controllers. Here the characteristics of a display could be controlled by attentive looking, which is also under voluntary control. For instance, when alpha was suppressed by attentive looking a series of visual displays could be presented at a rapid rate. A much slower rate plus a warning could be given when alpha occurred. In the case where there is a continuing inspection of stimuli required, then the rate of presentation of the various objects would be so regulated by attentive looking that the best inspection would occur. One can imagine a vehicle or machine which is unsafe if the operator is not attentive or alert. Such a machine could be automatically shut down if attentive looking flagged below a critical level.

Attention compensators. This is a special case of display controller. Here the display would magnify or exaggerate the visual display effect of attention to make up for an attention defect. For instance, when a person was not attentively looking at a visual display it would get brighter or clearer or larger, permitting a better reception of it.

Attention trainers. Here the goal would be to use feedback to tell a person when his brain rhythms indicated that he was alert. He would practice until he could voluntarily change the display indicating that attentive looking, or not, was achieved. Such training might help people to improve their attentive-looking behavior. They may learn an improved self-control of attention. Experimental studies show that by feedback training, control of the brain rhythms is improved (Nowlis & Kamiya, 1970; Peper & Mulholland, 1970).

In these applications I have talked about brain wave responses. It would be important also to study eye movement and pupillary changes to make displays controlled by eye behavior. In these ways we may improve the evaluation and automatic control of visual displays in terms of their effect on the orienting response of the viewer.

- 849 Mulholland, T., & Davis, E. Electroencephalographic activation: Non-specific habituation by verbal stimuli. Science, 1966, 152, 1104-1106.

A decrease in the duration of the electroencephalographic activation response to a series of different words: emotional, "neutral," and scrambled occurred. The response to "neutral" words was consistently briefer than that to the other words. This result is evidence of a nonspecific habituation of activation, which implies that habituation to classes of stimuli can occur.

- 850 Mulholland, T., & Evans, C. R. An unexpected artefact in the human electroencephalogram concerning the alpha rhythm and the orientation of the eyes. Nature, 1965, 207, 36-37.

In conclusion we will note that an extended series of experiments using a greater number of subjects is at present in progress. It is already clear that the effect already described may be found in marked fashion in 50 per cent of all subjects tested -- though in some individuals its occurrence is less reliable than in others. A number of variables, such as subjects' general ability to hold their eyes continuously in any given position, no doubt contribute, and it is hoped subsequently to identify these variables. However, at the moment it seems unlikely that any "screening" of individuals prior to their participation in an EEG experiment would be of much use, for the effect may suddenly appear in subjects who do not, on the first test, exhibit it.

Since performing the original experiments we have heard from Dr. M. D. Dewan, of the U.S. Office of Aerospace Research, who has independently observed that alpha occurrence is increased when his subjects were "looking upwards" with eyes closed.

- 851 Mulholland, T., & Evans, C. R. Oculomotor function and the alpha activation cycle. Nature, 1966, 211, 1278-1279.

As we have stated here, the concept of "attention" in relation to the alpha-activation cycle is not particularly useful in the interpretation of these results. A search of most of the literature concerning human "attention" and the EEG does not reveal any experiment in which oculomotor functions have been excluded as a cause of the EEG phenomenon supposed to be associated with "attention". Attention, is, in fact, simply assumed to be the relevant variable. However, the results we have reported can be explained in terms of the hypothesis that the alpha-activation cycle reflects the movements, accommodation and position of the eyes. In sum, such a hypothesis would imply that the electroencephalographic and oculomotor components of the orienting response are not merely coincidental and independent, but are so dynamically linked that oculomotor processes can modify the EEG response to stimulation. From this point of view (which will need to be considered in all future experiments linking "psychological" variables with the EEG) if there is any affect of "attention", it is on oculomotor functions which in turn cause a modification of the alpha-activation cycle.

- 882 Mulholland, T. B., & Peper, E. Occipital alpha and accommodative vergence, pursuit tracking, and fast eye movements. Psychophysiology, 1971, 8, 556-575.

The parietal-occipital EEG was recorded while subjects performed various fixation, accommodation, and tracking maneuvers with stationary and moving targets. For some experiments the target was continuously in view and independent of the EEG; in others, a feedback path connected the occurrence of parietal-occipital alpha with the visibility of the target. The results show that alpha attenuation or blocking is not due to "visual attention" but to processes of fixation, lens accommodation, and pursuit tracking. Saccadic movements were not reliably linked to alpha or alpha "blocking." The utility of feedback methods for testing the hypotheses that visual control processes are linked to the parietal-occipital alpha rhythms was demonstrated.

- 883 Mulholland, T., & Runnals, S. Evaluation of attention and alertness with a stimulus-brain feedback loop. Electroencephalography and Clinical Neurophysiology, 1962, 14, 847-852.

A simple electronic apparatus was so arranged that selected EEG frequencies in the alpha range caused a stimulus to occur. When alpha was suppressed the stimulus was automatically removed. When alpha recurred the stimulus was automatically presented again, etc. During this feedback stimulation the following phenomena were observed: 1. alpha tended to occur in a series of short "bursts" separated by periods of faster "no-alpha" activity; 2. the changes in the durations of alpha and no-alpha components over time were not simple inversions nor complements of each other; 3. the temporal pattern of alpha and no-alpha durations were significantly different for conditions of viewing and attempting to remain at an alert, attentive level compared to simple viewing when no such attempt was made. In general, alpha durations were shorter, no-alpha durations longer and the variance of alpha duration reduced during the condition requiring greater attention; 4. the distribution of "alpha" and "no-alpha" response durations was not Gaussian, resembling a Poisson distribution. The hypothesis was advanced that the feedback system fractionates "phasic" response latencies from predominantly "tonic" response durations (Sharpless and Jasper 1956). Application of the system to the study of internal attention states was described and other applications suggested.

- 884 Mulholland, T., & Runnals, S. Increased occurrence of EEG alpha during increased attention. Journal of Psychology, 1962, 54, 317-330.

In three experiments the occurrence of EEG alpha during continuing attention - sets and during recurring alerting responses was compared.

Alpha was frequently facilitated during periods of attention-sets or was little affected. On the other hand, the familiar suppressions of alpha occasioned by alerting to an external signal was clearly evident. The behavioral effects of both the attention-sets (on perceptual content) and alerting (giving a verbal report in response to an audible signal) were definite and consistent.

It was concluded that the term attention can refer to neither a qualitatively consistent behavioral nor neurophysiological entity and that the classical and familiar alpha-attention hypothesis refers to a special case, i.e., transitory alerting to an external signal.

- 886 Mulholland, T., & Runnals, S. A stimulus-brain feedback system for evaluation of alertness. Journal of Psychology, 1962, 54, 69-83.

A simple electronic apparatus so filtered the EEG that selected frequencies in the alpha range (recorded from parietal-occipital locations) automatically caused a stimulus to occur. When alpha was then suppressed, the stimulus was automatically removed. When alpha reoccurred the stimulus automatically occurred again, etc. During this feedback stimulation the following phenomena were observed: (a) alpha tended to occur in a series of short "bursts" separated by periods of no-alpha activity; (b) the changes of duration of the alpha component and the no-alpha component over time were not necessarily inverse. Durations of alpha increased slowly while durations of no-alpha decreased rapidly and then decreased more slowly. In some individuals the alpha bursts became shorter during feedback stimulation while no change was evident for the no-alpha durations. The variance of the alpha component showed a marked decrease while the variance of the no-alpha durations showed less decrease during feedback stimulation for some individuals; (c) for a small group of Ss tested here the temporal pattern of alpha and no-alpha response durations was significantly different for conditions of viewing and silently counting feedback flashes (more attention) compared to simply viewing the feedback stimulus. In general "alpha" durations were shorter, "no-alpha" durations longer and the variance of "alpha" durations was reduced during the period of internalized, silent counting of the stimulus; (d) the distributions of response durations were not Gaussian; (e) non-random variation of successive response durations sometimes occurred; (f) patterns of hypo- and hyper-alerting were described; (g) the hypothesis that the system fractionates "phasic" alerting response latencies from "tonic" and "phasic" alerting response durations was presented; and (h) some applications of the system to the study of "habituation" and "attention" and the effect of psychopharmacologic agents on these processes were suggested.

- 886 Mulholland, T., & Runnals, S. The effect of voluntarily directed attention on successive cortical activation responses. Journal of Psychology, 1963, 55, 427-436.

With a "feedback" loop, frequencies in the alpha range caused a stimulus automatically to occur. When alpha was suppressed the stimulus was automatically removed. When alpha reoccurred the stimulus was automatically presented again, etc. During feedback stimulation the following phenomena were observed: (a) the temporal pattern of system ON and OFF durations was significantly different for conditions of viewing and silently counting feedback stimuli compared to simple viewing when no such counting was required. In general, ON durations were shorter, OFF durations longer and the variance of ON durations reduced during the conditions requiring counting. (b) Internally directed attention gradients (produced by voluntarily directing attention to specific stimuli) were detected and evaluated. (c) It was noted that this system permits regulation of a stimulating machine by cognitive acts, and that extension of this control to other external systems would depend on the educability of volitional control of brain alerting.

857 Mundy-Castle, A. C. The electroencephalogram and mental activity. Electroencephalography and Clinical Neurophysiology, 1957, 9, 643-655.

1. The results concerning alpha rhythm support the view that it is related both to visual processes and to an attention or alerting factor. It is important, however, that attention, such as concentration during mental arithmetic or mental imagery, can occur without alpha blocking, as also can visual imagery reported as of maximal clarity. There is thus no one-to-one relationship between alpha blocking and either visualization or attention.

2. A fourfold classification of 4-7 c/sec rhythms is suggested as follows:

(i) slow alpha variants (rare in normals);

(ii) "theta I": not harmonically related to the alpha rhythm, yet suppressed by eye opening and/or mental activity;

(iii) "theta II": augmented during perceptual and imaginative activities and apparently unrelated to affective changes. Possibly similar to kappa and related rhythms;

(iv) "theta III": varies during emotional activities. Results from the analysis of theta rhythm in the clinical group maintain the consistent historical trend associating theta rhythm with emotional and cortical immaturity.

3. A bifold classification of beta rhythm is suggested as follows:

(i) "beta I": including fast alpha variants, and comprising fast rhythms which are suppressed during cortical activity;

(ii) "beta II": fast rhythms augmented during cortical activity.

It is tentatively proposed that the first relate to the analysis and registration of data projected on the cortex, the second to the mediation of information within the brain.

858 Mundy-Castle, A. C. An appraisal of electroencephalography in relation to psychology. Journal of the National Institute for Personnel Research, Monograph Supplement 2, 1958.

The final section considers psychological implications and developments arising from the neurophysiological findings. It discusses historical and recent studies of conditioning and EEG, the conditioning of responses to rhythmic stimulation, topographic studies of conditioned EEG responses, EEG evidence of inhibition, and the possibility of a neurophysiological analysis of conditioning. It concludes with an appraisal of experimental studies of relations between behaviour and the EEG, with its main emphasis on interrelations between central excitability, arousal theory, temperament, personality, learning and habituation.

When viewed as a whole, this paper suggests the EEG as of increasing importance in relation to psychology; this is most probably because of the profound advances which have occurred in neurophysiology during the last ten years or so. This new influence in psychology may well be a forerunner of a far more objective and physiological psychology than that which has obtained in the past, one which will not fail to take full account of what goes on inside the body, and especially the head, in its attempts at the analysis of behaviour.

- 859 Murrell, K. F. H. Laboratory studies of repetitive work: IV. Auto-arousal as a determinant of performance in monotonous tasks. Acta Psychologica, 1969, 29, 268-278.

An earlier proposal (Murrell, 1967) that performance changes on continuous and monotonous tasks could be explained by the production of hyper-arousal by auto-arousal is now rejected. Evidence is presented which suggests that auto-arousal does occur and that it is the consequent "damping down" corticofugal projections which cause the observed changes in performance.

- 860 Murrell, K. F. H. Temporal factors in light work. In W. Singleton, J. Fox & D. Whitfield (Eds), Measurement of man at work. London: Taylor & Francis, 1971.

The effects so far described have been seen most clearly in the skin conductance curves. If the skin conductance is a measure of arousal, the behavioural measurements have not, by any means, always followed prediction. One of the difficulties of this kind of work is that from the results obtained it would be possible to produce some which would show that nothing whatsoever has happened; equally as has been described above, results have been obtained which do support the views put forward. That this should be the case need not necessarily disprove the general thesis. It is not part of the proposition that auto-arousal will always occur in a given set of conditions. The very fact that the effects looked for occur only in some of the experiments is further evidence that we have been dealing with an arousal effect which can be manipulated at the will of the subject and over which the experimenter may have only partial control - if, in fact, he has any control at all.

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- 861** Naatanen, R. Selective attention and evoked potentials. Annales Academiae Scientiarum Fennicae, 1967, B-151.

Reports on 3 experiments which tend to suggest that enhancement of evoked potentials in reaction or discrimination tasks is not related to selective attention or selective perception. In Exp. I a visual task was used to focus attention. Potentials evoked by clicking sounds were found to be statistically larger during the periods of visual attention compared to the relaxed (no attention) periods. In Exp. II the effect of differential alertness was controlled by presenting relevant and irrelevant stimuli randomly. The relevant task was discrimination between light flashes, the irrelevant stimuli were clicks, or vice versa. Although some Ss were able to ignore the irrelevant stimuli and all did well on the relevant task, there were no statistically significant amplitude and latency differences between the potentials evoked by relevant or irrelevant tasks. In Exp. III relevant and irrelevant stimuli alternated regularly. This arrangement produced greater potentials for relevant stimuli. It is felt that this outcome suggests that the selective attention to different stimuli reported by others can be attributed to increased but nonspecific arousal due to anticipation of a relevant stimulus.

- 862** Naatanen, R. Anticipation of relevant stimuli and evoked potentials: A comment on Donchin's and Cohen's "averaged evoked potentials and intramodality selective attention". Perceptual & Motor Skills, 1969, 28, 639-646.

Donchin and Cohen (1967) reported having demonstrated amplitude differences of late components of occipital evoked potentials related to intramodal selective attention within the visual modality even under conditions in which the relevant stimuli could not be anticipated by S. They delivered flashes at irregular intervals from 2 to 3 sec and, timed independently of these, background reversals at irregular intervals from 3 to 4 sec on the same retinal location. The triangular test flash was superimposed on either of the background figures, one or the other of which was present at any given time. When S's attention was directed to the flashes, these elicited occipital potentials with larger late components than when attention was directed to the background reversals. Especially the late positive component (latency to peak 250 to 300 msec) was considerably enhanced. The same effect was reported to have been observed with respect to the occipital potentials elicited by the background reversals. It is suggested here that the effect was actually induced by the anticipatory and preparatory reactions to the presentation of the relevant stimuli, conditioned by the regularities in the stimulus sequence. These differential anticipatory and preparatory reactions might include momentarily increased cortical activation as well as simultaneous changes in peripheral receptor conditions, such as improved ocular fixation and accommodation in addition to increased diameter of the pupil. In this author's view, these nonspecific factors may have caused the evoked potential amplitude differences between relevant and irrelevant visual stimuli which were interpreted by Donchin and Cohen to reflect intramodal selective attention.

- 863** Naatanen, R. Anticipation of relevant stimuli and evoked potentials: A reply to Donchin and Cohen. Perceptual and Motor Skills, 1969, 29, 233-234.

Granted that the experimental paradigm used by Donchin and Cohen prevents S from anticipating the moment of delivery of the relevant stimulus as accurately as in the experiment of Chapman and Bragdon. The fact, however, that the interval between relevant stimuli was varied by Donchin and Cohen only within a relatively narrow range (2-3 or 3-4 sec) exposes their work to the same criticism they directed at Chapman and Bragdon's study: "as stimuli were presented periodically ... it is possible that subjects were alternately attending and not attending to visual inputs." Complete randomization of the stimuli would, in my opinion, have been the only way to eliminate this risk.

- 864** Naatanen, R. Evoked potential, EEG, and slow potential correlates of selective attention. Acta Psychologica, 1970, 33, 178-192.

This experiment was performed to clarify the interpretation of enhanced evoked potentials elicited by stimuli relevant to the task at hand, reported in recent studies on the neurophysiological basis of selective attention. The hypothesis was proposed that it is the regular presentation of relevant and irrelevant stimuli which is the crucial factor in inducing evoked potential amplitude enhancements, not selective attention thought by many investigators. Five subjects were used. Auditory stimuli were delivered, and every second click was made relevant by means of a rather difficult discrimination task. Evoked potentials were recorded over the occipital (O_2), vertex (C_z) and temporal (T_4) area of the cortex. The background EEG and slow potentials were also measured. The results indicated that under conditions in which the delivery of the relevant stimuli can be quite accurately anticipated, two of the five subjects showed before relevant, but not irrelevant, stimuli both a widespread decrease in the EEG amplitude and a large negative phase of the slow potential. These results are interpreted as showing nonspecific anticipatory and preparatory cortical activation preceding the relevant stimuli. In the light of the present results, it is probable that remarkable enhancement of the amplitudes of the potentials evoked by the relevant stimuli occurs in those and only those subjects who show nonspecific preparatory cortical activation preceding the relevant stimuli. It is suggested therefore, that the real reason for the enhanced amplitudes of potentials elicited by the relevant stimuli is the increased nonspecific cortical activation preceding these stimuli. The nonspecificity of this activation is indicated by the finding that also the occipital area was more activated when the subject heeded auditory stimuli than when he did not do so.

- 865** Naatanen, R. The inverted-U relationship between activation and performance: A critical review. In S. Kornblum (Ed.), Attention and performance IV, New York & London: Academic Press, 1973.

Behavioral efficiency of an organism is discussed in relation to the intensity aspect of its physiological responses. It frequently has been claimed, especially by proponents of activation level theories, that the relationship between "activation" and performance follows the form of an inverted U. According to these theories, there exists for each kind of performance an "optimal level of activation," usually of a moderate degree, at which the highest behavioral efficiency is reached. Data claimed to support the inverted-U curve is reviewed and it is concluded that the down turn of this curve after the "optimal level of activation" is an artifact of relatively uncontrolled behavioral direction, as well as of the ecological unrepresentativeness of such experiments. It is proposed that behavioral efficiency increases as a negatively accelerating function of the intensity of physiological response, as long as the patterning of the response remains appropriate with regard to the kind of performance involved.

- 866 Naatanen, R. Selective attention and evoked potentials in humans-a critical review. Biological Psychology, 1975, 2, 237-307.

Human evoked-potential research on the neurophysiological substrate of selective attention is reviewed. Most of these studies report enhanced amplitudes of potentials evoked by attended (task-relevant, meaningful, important, etc.) stimuli the results of which are generally regarded as providing an electrophysiological correlate for selective attention. In accepting such claims, there appears to be two major procedural problems generally not satisfactorily solved in these studies: (1) the inability to reliably separate the specific and non-specific physiological changes concomitant with selective attention from each other; and (2) inadequacy of peripheral sensory control possibly inducing contaminating changes already at the level of the proximal stimulus. Problem (1) originates from, and the importance of (2) is emphasized by, the temporal stimulus structure of experimental tasks in these studies which allows the subject to predict above the chance level the relevant events and, thus, to differentially prepare himself for these in advance (increased non-specific arousal and selective peripheral sensory orientation, the latter often made possible by insufficient control, have possibly been among these changes). Those studies to which these two (and other) remarks do not apply at all or only to an insignificant degree have generally shown no selective evoked-potential changes (or these changes have occurred only with a long latency ('P 3' or 'P 300') making their interpretation especially uncertain). There is one exception for this general notion, the reasons for and significance of which are dealt with in detail. Finally, the difficulties and inherent limitations of inferring brain events from scalp-recorded evoked-potential data, especially with respect to the important selective-filter hypothesis of selective attention, are extensively discussed and, in the light of these difficulties, some trends for future research proposed.

- 867 Naatanen, R., & Gaillard, A. W. The relationship between the contingent negative variation and the reaction time under prolonged experimental conditions. Biological Psychology, 1974, 1, 277-291.

Recorded vertex, frontal, and temporal contingent negative variations (CNVs) from 3 highly experienced Ss during the $S_1 - S_2$ interval of a prolonged simple reaction time (RT) task and correlated them with RTs obtained. Data were measured in 2 ways: objectively, by measuring the CNV by means of a computer; and less objectively, by measuring the CNV by means of a ruler from the computer-averaged graphs in the traditional manner. Several amplitudes, as well as the vertex, frontal, and temporal evoked potentials to S_1 and S_2 , were measured. No systematic relationship between different CNV measures and the RT could be observed. Whereas the amplitudes of the evoked potentials clearly habituated during the experimental session, the amplitudes of the CNV remained at their original values.

- 868 Naitoh, P. Sleep deprivation in humans. In P. H. Venables & M. J. Christie (Eds.), Research in psychophysiology. London: Wiley, 1975.

These illustrations demonstrate clearly that some of the effects of sleep deprivation on task can be easily detected with the aid of a polygraphic record. With continuous monitoring and recording of the EEGs and autonomic variables, we can eliminate experimental segments contaminated by effects of sleep deprivation.

- 869 Naitoh, P., & Hilbert, R. P. CNV-heart rate response under gradual sleep reduction. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

Anticipatory bradycardia was exhibited by the 4 subjects on trials of correct detections (Hits), excepting the very first session. This cardiac slowing in anticipation to the S_2 was defined as the fastest heart beat during the $S_1 - S_2$ interval minus the slowest heart beat observed near the time of the presentation of the S_2 . The results suggest that anticipatory cardiac slowing accompanying the responses of Hits was attenuated during sleep reduction. For 3 subjects, the product-moment correlates between anticipatory bradycardia and the elapsed time since the start of the experiment were -0.92, -0.72 and -0.62. The fourth subject, B. S., had a correlation of near zero, 0.07. When 7 January was taken as the baseline, anticipatory bradycardia was attenuated to 5-10 per cent levels of significance during sleep reduction.

The expected cardiac slowing to S_3 , which indicated response correctness, was also observed, but it was difficult to tease this component out from the natural tendency of heart rate to decrease at this point in time (i.e. 4 sec after the S_2 ; see Naitoh et al., 1973).

The relation of anticipatory bradycardia to the CNV magnitudes and reaction times is being analysed under 12 response contingencies (e.g. Hits with a high confidence, Hits with a medium confidence, et seq.).

- 870 Naitoh, P., Johnson, L. C., & Lubin, A. The effect of selective and total sleep loss on the CNV and its psychological and physiological correlates. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 213-218.

The present study confirms the previously published finding by Naitoh et al. (1971) that total sleep loss of one night attenuated the CNV magnitude and also confirms the results of studies on cardiac correlates of the CNV and CNV-like paradigms by Connor and Lang (1969), Coquery and Lacey (unpublished data), Lacey and Lacey (1970), and Papakostopoulos and McCallum (1973 this volume). The cardiac correlates of the present study were almost identical with those observed by Coquery and Lacey, despite the differences in types of S_s used (college students vs. Navy recruits), method of analysis (median heart rate response on beat-by-beat basis vs. mean heart rate response on time basis), and the nature of S_1 (a simple warning stimulus vs. discriminated warning stimuli). The cardiac correlates of the CNV, especially of phasic bradycardia in anticipation of S_2 , were not affected by REM, slow wave sleep and total sleep deprivations. Perhaps the cardiac correlates of the CNV reflected not a degree of sustained attention, but rather a subjectively experienced task demand and the willingness to exert more effort in order to compensate for the detrimental effects of sleep debit. Multiple correlations of 0.630 (for the baseline average data), 0.878 (for the recovery average data), 0.823 (after 3 nights of selected sleep deprivation) and 0.863 (after one night of total sleep deprivation) were obtained among the larger phasic bradycardia, the subjects' rating of exerting more effort, and that of feeling more task demands.

- 871** Naitoh, P., Kales, A., Kollar, E. J., Smith, J. C., & Jacobson, A. Electroencephalographic activity after prolonged sleep loss. Electroencephalography and Clinical Neurophysiology, 1969, 27, 2-11.

Alpha activity can be reasonably estimated by alpha index and, as such, it will be sufficient to indicate a gross sleep debt. In those who lack dominant alpha activity, the simple subjective ratings associated with standardized tasks may be used for detection of sleep debt. The poor indicators of sleep loss were 17-hydroxycorticosteroids, oral temperature, and time-off-target. Respiration rate, heart rate, and arterial pressure were useless in detecting even a gross sleep starvation.

- 872** Newton, F. A., & Bird, B. L. High frequency EEG correlates of cognition. Psychophysiology, 1977, 14, 83-84. (Abstract)

EEG literature has demonstrated that mental effort and concentration accompanying problem solving are positively correlated with low amplitude fast frequency beta activity. However, the vast majority of research has focused on frequencies less than 25 Hz, representing the low end of the beta spectrum. This investigation examines the relationship between a high beta rhythm with a center frequency at 40 Hz and problem solving. Relationships between 40 Hz EEG (38-42Hz), theta (4-7 Hz), alpha (8-13 Hz), beta (21-30 Hz), and 40 Hz EMG activity were also studied.

A total of 49 male university students were tested and divided into three groups: Group A (n=25) solved spatial problems, and 40 Hz EEG and beta were recorded from the O₁-P₃ lead; Group B (n=10) solved verbal, mathematical and spatial problems, and 40 Hz EEG was recorded from Cz-O₁ and Cz-O₂. Theta, alpha, and beta were recorded from Cz-O₁; Group C (n=14) solved spatial problems with the same recording sites as Group B. Recordings were made while subjects solved problems presented on slides and during pre- and post-baseline conditions. Raw EEG and EMG activity recorded from the neck-temporal muscles were monitored by analog filters. Stringent on-line controls in the form of comparator-logic circuits prevented counting 40 Hz EMG as 40 Hz EEG. Results indicated that for all three groups 40 Hz EEG was significantly greater during problem solving than during baseline. Beta (21-30 Hz) did not change from baseline to problem solving periods for Groups A and B, but was significantly less during the problem-solving period compared to baseline for Group C. 40 Hz EMG activity did not change for Group B and C, but was significantly greater during problem solving as compared to baseline for Group A. Theta and alpha rates were higher during baseline than problem solving. Results show 40 Hz EEG is specifically related to problem solving and can be dissociated from beta and EMG activity.

- 873** Nihei, Y., Honda, H., Shiga, N. & Maruyama, K. Contingent negative variation (CNV) and speed anticipation reaction test. Tohoku Psychologica Folia, 1974, 33, 71-75.

In a study with 32 bus, truck, and taxi drivers, relationships among contingent negative variation (CNV), simple reaction time, and performance on the Speed Anticipation Reaction Test, a test being utilized as one of the most sensitive tests for driver aptitude in Japan, were investigated. There was no significant correlation between the CNV amplitude and simple reaction time. However, some degree of negative correlation was found between CNV amplitude and speed anticipation reaction time ($p < .05$). There was a tendency for Ss who showed a semi-hasty reaction in the speed anticipation reaction test to yield larger CNV than that of the standard reaction (nearly accurate estimation) Ss. Ss who showed delayed reaction yielded a smaller CNV amplitude ($p < .01$). Thus, larger CNV amplitude of Ss did not always predict accuracy of performance.

- 874 Nitsch, J. R. Biorhythmus und Arbeit. [Biological rhythm and work.] Sicherheitsingenieur, 1972, 3, 252-257.

Human physiological and mental functions vary in accordance with a distinctly biphasic curve which peaks out during the day and reaches its lowest point during the night. Research has shown that sleep, work, and eating do not significantly affect this circadian rhythm. The effect of periodic environmental factors and the biological nature of the circadian rhythm are discussed. The second part of this study deals with the practical significance of circadian functional variations with special reference to appetite for work and circadian output peaks. A brief reference is made to conclusions relating to personnel selection and work organization.

- 875 Norman, A. Biotelemetry and developmental psychology: Preliminary observations and heart rate change during unrestrained activity. Proceedings of the Annual Convention of the American Psychological Association, 1970, 5, 313-314.

Discusses the biotelemetric recording of physiological changes in its potential application to developmental psychology. The relationship between heart rate (HR) and attention in freely moving Ss is 1 important area of investigation. It is possible to record HR changes with a small FM transmitter while S engages in unrestrained activity. The use of split-screen videotape makes it possible to precisely relate overt behavioral changes to beat-by-beat HR changes. It is anticipated that the use of developmental psychophysiology will now be extended to various groups, such as preschool children for whom there is little data in the literature.

- 876 Nosal, C. Zmiany szybkości reagowania pod wpływem hałasu. [Effect of noise on levels of performance and activation.] Przegląd Psychologiczny, 1968, 15, 72-86.

A significant correlation exists between the decrease in the RT and the increase in the GSR amplitude. This correlation shows that a slight increase in the activity level shortens the RT. When the activity level oscillates about the optimal GSR value, the RT tends to decrease (in the absence of noise). When the activity level is higher than the optimal value, the RT displays no definite trend (in noise).

The effect of noise on the distortion in the subjective estimation of the reaction time has been determined. The estimates were better in the absence of noise than in its presence. This implies that noise which increases the activity level disturbs the check of the results of the activity. It is known that such a check furnishes the subjects studied with information necessary to form subsequent responses to a particular stimulus.

- 877 Nouaille-Degorce, J., & Riotte, M. Problemes theoriques et pratiques de l'alternance veille-sommeil. [Theoretical and practical problems of wake-sleep alternation.] Aerospace Medicine, 1970, 41, 330. (Abstract)

Discussion of the importance of the waking-sleeping cycle in military service, where command requirements are to utilize personnel whose qualities and duration of vigilance can be modified. The problem is considered in two aspects: that of the perturbation of the nyctohemeral rhythms of sleep and its consequences, and that of the possibility of making a subject sleep or stay physiologically awake for an appropriate time. The concept of the circadian rhythm and the physiology of sleep are reviewed, as well as present knowledge of the structures responsible for vigilance. The effects of various drugs on wakefulness are outlined, and methods for studying vigilance are considered.

- 870 Novak, S., Diaz, J., & Leinwand, S. Latency of alpha blocking as a function of photic stimulation during the cardiac cycle. Psychophysiology, 1973, 10, 21-26.

Changes in reaction time during the cardiac cycle have been reported by a number of investigators. The present study concerns changes in the latency of alpha blocking as a function of the time of presentation of photic stimulation during the cardiac cycle. Stimuli were presented at intervals of 0, 25, 50, 75, 100, 200, 300, 400, and 500 msec following the peak of the R-wave of the EKG. Alpha blocking latency was found to be shorter for stimulus presentation early in the cardiac cycle.

- 879 Nunn, C. M. H., & Osselson, J. W. The influence of the EEG alpha rhythm on the perception of visual stimuli. Psychophysiology, 1974, 11, 294-303.

An experiment is described which was designed to test the hypothesis that brief visual stimuli would not be perceived when they occurred during certain phases of the EEG alpha rhythm. The results agreed with the hypothesis. It was concluded that the alpha rhythm is a correlate of the activity of a 'neuronic shutter' which periodically prevents the reception or processing of visual information by the brain.

The procedure used was such that there was no necessity for the subjects to pay attention to the stimuli; indeed, efforts were made to avoid such attention. This methodology was thought to be of importance in obtaining a positive result.

- 880 Obrist, P. A. Cardiovascular differentiation of sensory stimuli. Psychosomatic Medicine, 1963, 25, 450-459.

Replication was achieved of previous demonstrations that sensory stimuli involving continuous environmental input decelerate heart rate even in the presence of increased sympathetic tonus as measured by skin resistance. Systolic blood pressure and pulse pressure were not found to change, indicating that the bradycardia was not induced by baroreceptor effects. On the other hand, noxious stimuli and a conceptual task resulted in heart rate acceleration, increased systolic blood pressure, peripheral vasoconstriction, and decreased skin resistance. This evidence is taken to be consistent with a conceptual scheme which considers cardiovascular activity as instrumental in enhancing, or rejecting, environmental inputs.

- 881 Obrist, P. A., Howard, J. L., Lawler, J. E., Galosy, R. A., Meyers, K. A., & Gaebelstein, C. J. The cardiac-somatic interaction. In P. A. Obrist, A. H. Black, J. Brener & L. V. DiCara (Eds.), Cardiovascular psychophysiology: Current issues in response mechanisms, biofeedback, and methodology. Chicago: Aldine, 1974.

Our purpose for studying the relationship between cardiovascular and somatic activity is to shed some light on the biological mechanisms by which behavioral and cardiovascular processes interact. The necessity to resort to such a biological-mechanistic strategy is indicated by the ever increasing body of evidence which indicates that the relationship between behavioral and cardiovascular events is quite complex and not understandable at a conceptual level which links cardiovascular changes in some direct-unidimensional manner to behavioral processes such as motivational or affective states. The complexity of the problem is perhaps best illustrated by the variety of heart rate changes that have been observed in simple behavioral paradigms with heart rate sometimes increasing, decreasing, or changing in a biphasic or even triphasic manner with regard to direction of change. There has been some effort to understand these heart rate effects by recourse to concepts dealing with the organism's receptivity to environmental events. For example, decreases in heart rate have been associated with the facilitation of organism-environmental interaction, such as with orienting responses in one context (Graham and Clifton 1966) and with attention to environmental events in another (Lacey and Lacey 1970), while heart rate increases have been proposed to be associated with defensive reflexes or rejection of environmental intake. While there is evidence which indicates a certain validity to these positions (e.g., Chapter 26, Lacey and Lacey), there is still other evidence which is not consistent with them (see Chapter 25, Elliott; Elliott 1972; Hahn 1972, for overviews). To us a biological strategy which focuses on the extrinsic neural-humoral mediating mechanisms which evoke cardiovascular effects would facilitate the resolution of such inconsistencies as well as act to delineate the nature of the interaction between behavioral and cardiovascular processes in general. The justification for such a biological strategy should become apparent in the following sections of this chapter. They boil down to the point that we are dealing with a very complex biological system both in regard to the function it serves and in the manner it is controlled in achieving this function. For example, we shall present data which shows over a 30-second period commencing with the preparatory signal of a stressful reaction task - a complex display of heart rate changes which to us is uninterpretable with regard to behavioral significance without consideration of the role of the cardiac innervations and of the relationship of these heart rate changes to somatic activity.

- 882 Obrist, P. A., Howard, J. L., Sutterer, J. R., Hennis, R. S., & Murrel, D. J. Cardiac-somatic changes during a simple reaction time task: A developmental study. Journal of Experimental Child Psychology, 1973, 16, 346-362.

The relationship during a simple reaction time task between heart rate and four measures of task irrelevant somatic activity was evaluated in four age groups of children, i.e., 4-, 5-, 8-, and 10-year-olds and young adults, in order to evaluate further a hypothesized coupling of cardiac and somatic activity. At all age levels, phasic decreases in both heart rate and somatic activity coincident with performance were found with the magnitude of the effect increasing with age only on three somatic measures. However, tonic levels of both heart rate and somatic activity decreased with age. Performance on the reaction task was found to be inversely related to the age-related phasic somatic effects as well as age-related tonic heart rate and somatic activity.

- 883 Obrist, P. A., & Webb, R. A. Cardiac-somatic coupling and reaction time. Psychophysiology, 1968, 4, 504. (Abstract)

Two experiments are reported which evaluate further in human Ss the relationship between heart rate deceleration and the attenuation of several different aspects of somatic-motor activity. In one experiment, 48 Ss were given 100 trials using a simple reaction time task with a fixed 5 sec foreperiod. It was observed that around the period of responding, heart rate decelerated, and bursts of spontaneous EMG activity from the chin, as well as respiratory frequency and amplitude decreased. The magnitude of the cardiac effect was directly correlated with the magnitude of the decrease in all three somatic measures. Similarly, performance, i.e., faster reaction time, was directly correlated to the magnitude of both the cardiac deceleration and the attenuation of two of the three somatic activities.

A second experiment involving 26 Ss used simple aversive conditioning procedures with a 7.0 ISI and controlled respiration. Here, still another aspect of somatic activity, eye movements and blinking, were found to decrease around the time the UCS was expected on nonreinforced test trials. The magnitude of this effect was directly correlated with the anticipatory cardiac deceleration. The data also indicated that the inhibition of eye movements and blinking may more sensitively reflect the attenuation of somatic activity which these conditions initiate than bursts of spontaneous EMG activity.

- 884 Obrist, P. A., Webb, R. A., & Sutterer, J. R. Heart rate and somatic changes during aversive conditioning and a simple reaction time task. Psychophysiology, 1969, 5, 696-723.

Four experiments are reported, all of which are concerned with evaluating in human Ss the relationship between the deceleration of heart rate, observed to anticipate both aversive and non-aversive stimuli, and several aspects of somatic-motor activity. In a simple reaction time task, a decrease in spontaneous bursts of EMG activity and both respiration amplitude and frequency were found to be concomitant with the deceleration of heart rate during the foreperiod and to be directly correlated with reaction time. The decrease in anticipatory somatic activity to an aversive stimulus was found in a second experiment to extend to spontaneous eye movements and blinks, which also had a marked concomitance with the anticipatory deceleration of heart rate. However, experimentally imposed somatic activity, i.e. continuous finger tapping, increased in intensity around the time the UCS was expected. A third experiment provided additional evidence that the anticipatory cardiac deceleration to aversive stimuli was not mediated significantly by respiratory maneuvers. Finally, evidence was provided that the basis for the spontaneous EMG bursts may be related to somatic responses elsewhere in the body, such as postural adjustments.

- 898 Obrist, P. A., Webb, R. A., Sutterer, J. R., & Howard, J. L. Cardiac deceleration and reaction time: An evaluation of two hypotheses. Psychophysiology, 1970, 6, 695-706.

The purpose of this experiment was to evaluate two hypotheses concerning the basis of the association between performance on a simple reaction time (RT) task and the deceleration of heart rate found as the S responds. The RT task consisted of 96 trials in which the foreperiod was randomly varied between 2, 4, 8, and 16 sec. Two groups of 31 Ss each were used, with the cardiac response blocked pharmacologically in one group, in order to determine if the occurrence of the cardiac response facilitated performance through an afferent feedback mechanism. Two aspects of somatic activity, EMG bursts from chin muscles and eye movements and blinks, were also assessed in order to determine if the cardiac response and the associated behavioral facilitative effects were linked to a common mediating process involving cardiac deceleration and the inhibition of ongoing, task-irrelevant somatic activities. The latter hypothesis was consistently supported. Blocking the cardiac response did not significantly influence performance. However, a within-S analysis revealed a pronounced direct relationship between RT and the magnitude of the inhibition of somatic effects and the magnitude of the cardiac deceleration when the latter was not blocked pharmacologically. These data along with several other lines of evidence are considered to indicate that heart rate deceleration may not be significantly involved in an afferent mechanism but rather can be best understood as a peripheral manifestation of central processes.

- 899 Obrist, W. D. Electroencephalographic approach to age changes in response speed. In A. T. Welford & J. E. Birren (Eds.), Behavior, aging, and the nervous system. Springfield, Ill.: Thomas, 1965.

An attempt has been made to review the relevant literature on EEG and reaction time, with the hope of suggesting possible mechanisms for senescent changes in speed of response. Any hypothesis regarding such a mechanism must explain, not only the lengthening of reaction time, itself, but also the considerable increase in its variability, both within and between individuals. As reported previously (Obrist, 1953), the standard deviation representing individual differences in reaction time may be twice as great for elderly people than for young adults, while intra-individual variability increases 50 per cent. The question arises whether the large individual differences and moment to moment variations characteristic of the senescent EEG are related to the observed variability in reaction time.

An additional factor, not considered here, is the role of the autonomic nervous system in regulating both EEG potentials and speed of response. Studies on the relation of reaction time to cardiac cycle (Birren, Cardon and Phillips, 1963) might well tie in with the concepts of reticular activation and cortical excitability mentioned above.

Before definitive answers can be obtained, a more direct approach seems necessary. One possibility is the modification of EEG frequency by experimental procedures, while simultaneously measuring reaction time. Induced anoxia might be one such method. Other techniques for altering EEG frequency might also be used, such as photic driving (Mundy-Castle, 1953), sensory deprivation (Zubek and Welch, 1963), or prolonged body immobilization (Zubek and Welgosh, 1963). In this connection, Williams and associates (1962) have already demonstrated a high correlation between reaction time and EEG, when both variables are altered by sleep deprivation. The application of these specialized techniques to problems of aging is an intriguing challenge for future research.

- 007 Offenloch, K. Neurophysiological assessment of functional states of the brain. In K. E. Klein (Ed.), Methods to assess workload. AGARD Conference Preprint, No. 216, 1977. (Available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.) (Abstract)

By neurophysiological methods functional states of the brain can be assessed with a precision that surpasses that of classical psychological methods.

Not only neurological syndromes, but also slight changes on the vigilance scale as well as functional changes associated with cognitive and intellectual functions can be correlated with the electrical activity of the brain and thereby objectively determined.

- 000 Ogle, W. T. Lateral eye movements: Their relationship to reading speed, cardiac responsivity and ability to process speeded information in the visual and auditory modes (Doctoral dissertation, Washington University, 1971). Dissertation Abstracts International, 1972, 33, 1293B. (University Microfilms No. 72-17, 958)

In the present experiment, we explored the relationship between the tendency of individuals to look to the right or the left while answering questions and their reading speed, eye movements during reading, cardiac responsivity, modality preferences and ability to handle speeded information in the visual, auditory and audio-visual modes. Forty-eight college freshmen and sophomores, twenty-four of whom were classified as right movers and twenty-four as left movers, took five tests. The first test was a battery of twenty questions, during which the direction of their eye movements in responding to the questions was noted; eleven or more responses in one direction resulted in the individual being classified as a mover in that direction. A majority of subjects made 75% or more of their responses in one direction. The Stroop Word Color Test was then administered. Next two reading passages were given, one of which was read silently and the other orally. During the reading of these two passages, the subject's eye movements were recorded. Finally, each subject took a speeded information processing task, which consisted of nine conditions: for each of three modes of presentation, auditory, visual and audio-visual, there were three speeds of presentation, 200, 250 and 300 wpm. The subject's heart rate was monitored throughout the entire experiment. A series of hypotheses about right and left mover performance on each of these tests was examined.

From the data it was concluded that:

(1) Left movers demonstrated greater interference in reading the Stroop Word Color Test than did right movers.

(2) Right movers read faster than left movers in both silent and oral reading.

(3) Left movers are generally poorer readers when reading silently. Analysis of their eye movement records showed that left movers used a larger number of fixations, made more regressions, and had pauses of longer duration in reading silently than did right movers.

(4) The eye movement factor that seemed to be largely responsible for the longer reading time of left movers was pause duration. Only pause duration differentiated between right and left movers on both the oral and silent reading passages, with left movers always showing longer pause durations.

(5) Left movers show greater cardiac responsivity to stress, responsivity being defined by cardiac acceleration. In response to the cue card of the Stroop Word Color Test left movers showed a greater cardiac acceleration than did right movers. In response to the speeded information processing task, left movers showed acceleration, while right movers showed cardiac deceleration.

(6) A greater number of left movers preferred to receive information in the auditory mode than did right movers.

888 O'Gorman, J. G. Change in stimulus conditions and the orienting response. Psychophysiology, 1973, 10, 465-470.

A review of studies of the orienting response (OR) to variation in the properties of a stimulus following habituation indicates that not all human Ss respond with an OR to changes of which they are aware and that the only conditions which have been found consistently to elicit the OR are an increase in the intensity of the stimulus and change in the modality of its presentation. These findings pose problems for the theory of the OR advanced by Sokolov (1960) which makes no allowance for a failure to respond to a detectable change in stimulation and which relies for support on evidence that the OR is not elicited solely as a consequence of the activating effects of stimulation. To clarify some of these problems it is suggested that future work should investigate the effect of complete omission of the stimulus on the OR and the contribution of individual differences in physiological responsiveness and perceived significance of a change to elicitation of the OR.

889 O'Hanlon, J., Jr. Adrenalin, noradrenalin and performance in a visual vigilance task. (Report No. 750-5). Goleta, Cal f.: Human Factors Research, Inc., 1964.

An experiment was undertaken to determine the relationship between signal detection performance and plasma concentrations of adrenalin and noradrenalin in adult male observers undertaking a visual vigilance task.

Signal difficulty level was equated for each observer in a preliminary experiment and each individual was then classified as either a decremting or non-decremting observer on the basis of his performance on a conventional visual vigilance task.

In the subsequent experiment, six decremting and three non-decremting observers undertook a conventional visual vigilance task. Seven other decremting observers served as controls and viewed movies under otherwise identical conditions. Blood samples were drawn from the observers periodically during the vigilance task and these were analyzed fluorometrically for adrenalin and noradrenalin.

It was concluded that the level of circulating adrenalin declines in decremting observers during a conventional vigilance task in a manner positively related to their performance on the task. The data also suggest that the amount of circulating adrenalin is differentially affected in decremting and non-decremting observers.

No conclusions were reached regarding the observers' noradrenalin production during the vigil. task. Remarkable elevations of some observers' noradrenalin levels were seen in both experimental and control conditions, but this finding was not consistent throughout the group.

- 891** O'Hanlon, J. F., Jr. Adrenaline and noradrenaline: Relation to performance in a visual vigilance task. Science, 1965, 150, 507-509.

Concentrations of adrenaline and noradrenaline in the circulating blood were measured in blood samples taken from subjects as they performed a visual vigilance task or viewed movies, both under identical conditions. For those subjects whose vigilance performance deteriorated it was concluded that the concentration of circulating adrenaline decreases as a function of time in a vigilance task but not under "relaxed" conditions, such as watching motion pictures.

- 892** O'Hanlon, J. F., Jr. Vigilance, the plasma catecholamines, and related biochemical and physiological variables (Report No. 787-2). Goleta, Calif.: Human Factors Research, Inc., 1970.

Twelve young men were selected as subjects from a larger group of applicants. They performed a simple signal detection task while seated in a specially constructed chamber. The task consisted of responding to each in a series of light pulses (1 sec) occurring on a visual display at a rate of once every 3 seconds. There were two types of pulses: the brighter was a signal, the dimmer, a nonsignal. After each pulse the subjects had to indicate one of four levels of confidence that a pulse was a signal.

After preliminary studies, each subject undertook a primary experiment in which he performed the basic task on two separate occasions. In V1, signals were easier to identify and in V2, they were more difficult. On both occasions, the subjects performed under alerted and monotonous conditions. On yet another occasion, they experienced a control condition (C) in which they merely viewed a series of bland slide projections. Correct and false signal identifications were measured in V1 and V2. Adrenaline, noradrenaline, free fatty acids (FFA), and glucose (G) were measured in serial blood samples taken in V1, V2, and C. Mean and variability of heart rate (HR and SD HR), basal palmar skin conductance (BC), galvanic skin response frequency (GSR), respiratory rate (RR), and neck muscle tension (T) were measured continuously in V1, V2, and C.

The major conclusions were (1) the catecholamine hormones are always active in the regulation of metabolic processes; (2) physiological arousal increases from resting as subjects begin a vigilance task and declines to resting as their performance deteriorates during the tasks; (3) heart rate variability is closely related to vigilance and a measure of the heart rate variability might be valuable as an index of vigilance; and, (4) circulating adrenaline is related to vigilance, as predicted.

- 893** O'Hanlon, J. F., Jr. Heart rate variability: A new index of driver alertness/fatigue (Report No. 1712-1). Goleta, Calif.: Human Factors Research, Inc., 1971.

This was an investigation of the relationship between heart rate variability (HRV) and driver performance, and a preliminary test of an experimental alertness indicator (EAI), i. e., a device for measuring HRV. Three drivers drove on a round-the-clock basis for 5 days over a 364-mile circuit on a California highway. HRV and driver error frequency were recorded and analyzed to determine effects of driving time, rest breaks, traffic event frequency, and other variables. The results showed that (1) HRV increased markedly with driving time; (2) HRV recovered after rest; (3) HRV might have reflected features of the highway's geometric configuration; (4) HRV dropped substantially after the occurrence of events which re-alerted the drivers; and (5) HRV was little influenced by traffic event frequency per se. It was concluded that HRV is related to driver alertness/fatigue and that the EAI has promise of being useful for estimating the level of driver alertness.

- 894 O'Hanlon, J. F., Jr., & Beatty, J. Catecholamine correlates of radar monitoring performance. Biological Psychology, 1976, 4, 293-304.

Two experiments were conducted in which target detection performance was measured for male and female subjects engaged in a simulated radar monitoring task. In the first, 20 subjects performed for 2 h; in the second, 28 subjects for 1 h. Adrenaline excretion rate was significantly correlated with performance efficiency in both cases. Task duration and subject sex had no effect upon that correlation. The results of the two experiments were combined to show a general adrenaline/performance relationship.

- 895 O'Hanlon, J. F., & Beatty, J. Concurrence of electroencephalographic and performance changes during a simulated radar watch and some implications for the arousal theory of vigilance. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

A simulated sea-surveillance radar monitoring task was employed to study the relationships between target detection performance and various physiological indices of arousal. Twenty subjects performed the task under different conditions designed to elicit differences in performance and arousal. Detection performance efficiency deteriorated as a function of time during a prolonged radar watch and improved during short alerted tests. Electro cortical changes involving the percentages of theta, alpha and beta waves in the spontaneous EEG were consistent in showing a relationship between arousal and vigilance. Mean changes in heart rate occurred in parallel with performance and electro cortical changes under certain conditions, but the former were not correlated with the latter on an individual basis. The work is viewed as supporting an extension of the arousal hypothesis of vigilance into more practical occupational settings.

- 896 O'Hanlon, J. F., & Horvath, S. M. Physiological reactions of men performing monotonous work. Physiologist, 1969, 12, 319. (Abstract)

The blood concentrations of adrenaline (A), noradrenaline (NA), free fatty acids (FFA) and glucose (G), and the heart rate (HR), respiratory rate (RR), palmar skin conductance (C) and neck muscle tension (EMG) were studied in 11 men under basal conditions and in each of three different experimental conditions. The latter were two monotonous (vigilance) tasks that differed in difficulty, and a control task requiring relaxed attention. In experimental conditions the subject sat within a special chamber which permitted him to perform the task while blood samples could be taken and electrophysiological recordings made without alerting him to the fact. [A] and [NA] were analyzed by a new, uniquely sensitive assay. Comparing both vigilance tasks to the control the results were: [A] was higher at onset but no different later; [G] was no different; HR was higher but HR variability was much less; RR was higher; and C was greater but C variability was much less. [NA] increased in all tasks in a manner related to [FFA] and EMG. [A], HR variability, RR, C, and EMG were related to vigilance performance. Conclusion: monotonous "mental" work evokes widespread physiological reactions, some of which parallel performance.

- 897 O'Hanlon, J. F., & Horvath, S. M. Interrelationships among performance, circulating concentrations of adrenaline, noradrenaline, glucose, and the free fatty acids in men performing a monitoring task. Psychophysiology, 1973, 10, 251-259.

This investigation was to determine the interrelationships among circulating concentrations of adrenaline, noradrenaline, glucose, and "free" fatty acids ([A], [NA], [G], and [FFA], respectively) in 11 men at rest and while performing "mental" work, i.e., a visual monitoring task. They performed the task and on another occasion served in a control condition where they merely watched slide projections. Basal levels of both [A] and [NA] were inversely related to [G]. [A] increased initially during the task but later returned to its basal level. The decline in [A] paralleled performance in the task. [A] declined to below its basal level in the control condition. [NA] was not related to performance in the task. [G] and [FFA] were elevated with respect to corresponding basal levels in both the task and the control condition. The bearing of the results upon current theories of human vigilance and psychophysiological mobilization during mental work was discussed.

- 898 O'Hanlon, J. F., Jr., & Horvath, S. M. Neuroendocrine, cardiorespiratory, and performance reactions of hypoxic men during a monitoring task. Aerospace Medicine, 1973, 44, 129-134.

Eight unacclimatized male subjects performed a 3 hr visual monitoring task while inspiring an oxygen-nitrogen mixture with $P_{O_2} = 90$ mm Hg (4,570 m equivalent). They performed the same task inspiring a mixture with $P_{O_2} = 159$ mm Hg (sea level). Heart rate (HR), ventilatory volume (V_E), and respiratory rate (RR) were measured and average tidal volume (V_T) was calculated. Serial blood samples were obtained for determinations of plasma cortisol ([C]), noradrenaline ([NA]), and adrenaline ([A]).

Monitoring performances were impaired by low P_{O_2} . HR and V_E increased as expected. Concurrently, [C] and [A] increased, and [NA] decreased. Strong correlations were found between performance impairment and each of the following: 1) increased V_T ; 2) decreased RR; and 3) increased [C]. It was concluded that human vigilance is rapidly and, in individual cases, severely impaired by hypoxia experienced inspiring the low P_{O_2} and that the degree of impairment may be predicted from measurements of concurrent physiological changes, particularly that involving [C].

- 899 O'Hanlon, J. F., Jr., & Kelley, G. R. A psychophysiological evaluation of devices for preventing lane drift and run-off-road accidents (Report No. 1736-F). Goleta, Calif.: Human Factors Research, Inc., 1974.

Several signs of progressively declining arousal were observed in the Ss as a function of elapsed driving time. These included: (1) slowing of the mean heart rate; and (2) slowing of the EEG alpha rhythm with rising electrical power within the alpha frequency band. These physiological changes occurred concurrently with progressive deterioration in the Ss' lateral road-tracking performance and vehicle speed control.

- 900 O'Hanlon, J. F., & Kelley, G. R. Comparison of performance and physiological changes between drivers who perform well and poorly during prolonged vehicular operation. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

The study consisted of three separate experiments, conducted on different California State Highway circuits. The results were obtained from an extensive reanalysis of data, which had the purpose of discriminating performance and physiological differences between groups of drivers who operated a specially instrumented vehicle well or poorly under prolonged, monotonous night driving conditions. The vigilance of better and poorer groups of drivers, defined by the frequency of inadvertent drifting from the assigned traffic lane, deteriorated to different degrees. Self assessments of alertness and fatigue were related to driving performance of better and poorer groups on the same highway but not between different highways. Better and poorer groups of drivers differed with respect to mean heart rate, heart rate variability, and power within the alpha, theta, and delta electroencephalogram (EEG) frequency bands. The types and degrees of physiological differences were strongly dependent upon the driver sample and highway circuit. Finally, unequivocal EEG signs of transient sleep were found in a few drivers showing extreme behavioral signs of fatigue and low vigilance.

- 901 O'Hanlon, J. F., Jr., Royal, J. W., & Beatty, J. EEG theta regulation and radar monitoring performance in a controlled field experiment (Report No. 1738-F). Goleta, Calif.: Human Factors Research, Inc., 1975.

Fourteen Naval Petty Officers, rated either as Air Controller or Operations Specialist (radarman), and stationed at the USN Pacific Missile Range, Point Mugu, California, were trained to suppress parietal-occipital theta activity in EEG. Each subject then performed a 3-hour vigilance task on two occasions, once with and once without theta contingent feedback. The task was administered using real radar equipment and imagery. It consisted of observing a display to detect the occasional appearance of a simulated "missile" contact which rapidly moved from the display periphery to its center. Missile detection latency during the third hour of the task was better with feedback, although the result was only marginally significant ($p < .10$). Theta activity was, however, significantly lower in the feedback condition. Two subjects who alone showed the "vigilance decrement" without feedback performed much better while suppressing theta activity when feedback was administered.

- 902 Ohkubo, T. Psycho-physiological reactions of vehicle drivers under long distance driving. Proceedings of the 6th Congress of the International Ergonomics Association, 1976, 299-303.

The human performances while driving of both skilled and unskilled drivers totaling 4 male university students mainly between 22-24 years of age, were investigated on the three different kinds of road conditions such as a high speed automobile test course, a common road and the highway. The relationship between driving skill and psycho-physiological functions was discussed. Results show the difference due to the degree of skill in driving with some such physiological parameters as pulse level and CFF. The external driving environment and the driving hours were also greatly influential.

- 903 Ohman, A., & Lader, M. Selective attention and "habituation" of the auditory averaged evoked response in humans. Physiology and Behavior, 1972, 8, 79-85.

The study examined the effects of direction of attention and interstimulus interval on the rate of amplitude decrement over time of the vertex auditory evoked response in humans. Short-term or stimulus-by-stimulus changes were studied by averaging across 24 discretely presented trains each of 10 click stimuli. Long-term or train-by-train changes were studied by averaging over successive pairs of trains. When attending to the clicks, the subject performed a reaction-time (RT) task with the click as stimulus; when ignoring the clicks he performed RTs to a visual stimulus. Both RT tasks were performed with irregular interstimulus intervals of 2.4 - 3.6 and 8-12s, each of the 8 subjects being thus studied on four occasions. Attending to the stimuli and long interstimulus intervals enhanced the P_1 - N_1 - P_2 components. Amplitude decreased over time both for stimulus-by-stimulus and train-by-train averages. Somewhat unexpectedly, there was a slight but significant tendency towards a steeper slope for the attending and long interstimulus interval conditions, probably following on the larger initial responses for these conditions.

- 904 Olst, E. H. Van, Oriebeke, J. F., & Fokkema, S. D. Skin conductance as a measure of tonic and phasic arousal. Acta Psychologica, 1967, 27, 262.

This paper offers a number of suggestions, that are inspired by current experimental literature and neurophysiological findings.

- 905 Opton, E. M., Jr. Electroencephalographic correlates of performance lapses on an attention task in young and old men. (Doctoral dissertation, Duke University, 1963). Dissertation Abstracts, 1964, 25, 3115-3116. (University Microfilms No. 54-11, 736)

EEG amplitude declined from before to after the stimulus when correct responses were made; and amplitude rose when errors of omission were made. There was no change in amplitude from before to after neutral stimuli or in the control conditions. The finding of desynchronization with correct responses was consistent with the results of other studies, but the augmentation of EEG amplitude with omission errors was unexpected. The transient nature of the increase in amplitude suggested an explanation in terms of inhibition. It was noted that many earlier studies have indicated that a variety of types of behavioral inhibition are accompanied by augmentation of EEG alpha amplitude.

Age differences in EEG amplitude were not statistically significant. The trend was for old subjects to show greater desynchronization with correct responses, but also greater increase in amplitude with omission errors than young subjects. Because there was no significant age difference in either performance or EEG it was not possible to answer the question whether age-related lapses of performance are associated with simultaneous age-related EEG phenomena.

- 906 Orlebeke, J. F. The cardiac component of the orienting reflex as a function of the pre-stimulus level. Proceedings of the 2nd Meeting of Psychologists from the Danubian Countries, Smolenice, Czechoslovakia, 28 Sept. - 3 Oct. 1970. [abstract in Studia Psychologica.]

The fact that pre-stimulus level is a scarcely controlled variable in 'heartrate-OR' research was hypothesized to be a major cause of the uncertainty as to the exact form of the OR in heartrate. Deceleration of HR during the first few beats was characteristic for all fifty-seven Ss. This decrease was significantly more pronounced for Ss with a high pre-stimulus level as compared with Ss with a low pre-stimulus level. After this first deceleration, acceleration followed which significantly surpassed the original pre-stimulus level only for the low stimulus level Ss. The first deceleration, averaged over all Ss, could be found only on the first two trials. Later trials showed a slow, long run acceleration.

- 907 Ornitz, E. M., Ritvo, E. R., Carr, E. M., LaFranchi, S., & Walter, R. D. The effect of sleep onset on the auditory averaged evoked response. Electroencephalography and Clinical Neurophysiology, 1967, 23, 335-341.

1. The auditory averaged evoked response (AER) was measured at the vertex in normal children and adults during the transition from wakefulness to sleep and throughout the night.

2. The amplitude of wave N₂ at sleep onset was compared to values obtained during subsequent non-REM sleep.

3. The largest amplitude of wave N₂ of the auditory AER occurred within 10 min of sleep onset regardless of state of consciousness.

4. The influence of sleep onset per se on wave N₂ amplitude was greater than the effect of stage of sleep.

908 Orr, W. C. The relationship between stimulus information, reaction time, and cortical habituation (Doctoral dissertation, Washington University, 1969). Dissertation Abstracts International, 1970, 30, 3411B-3412B. (University Microfilms No. 69-22, 549)

This investigation was an attempt to study systematically the effects of uncertainty, or stimulus information, on the rate of cortical habituation. Subjects were randomly assigned to one of three groups varying in uncertainty. Group I was presented with a random series of tones with a regular intertrial interval and instructed to respond to all tones. Group II was presented with the same series of tones and instructions but with a random intertrial interval. Group III was treated exactly the same as group II except they were required to respond only to one of the two different tones presented. EEG alpha desynchrony duration, GSR conductance change, and reaction time (RT) were the dependent measures.

The results showed uncertainty to have no significant effect on any of the neurophysiological measures. There was, however, a significant effect on the RT measure. There was no significant correlation between the magnitude of the EEG and GSR responses, nor was there any between these measures and RT. The GSR and EEG showed no decrease in the percent of responses, no habituation, and no group differences. There was no decrease in the frequency of the dominant alpha activity as a result of the experimental procedure.

The lack of significant group differences was interpreted as due to the RT task which may have raised the level of arousal for all groups, and perhaps their physiological responsiveness. This could have had the effect of equalizing all Ss on these variables, thus reducing between group differences. It was shown that, contrary to prevailing notions, habituation can occur without noticeable decreases in cortical or behavioral arousal. This, along with the lack of significant relationships between both GSR, EEG and RT indicated that current notions regarding the orienting response as dependent upon a unitary cortical model must be revised. The present findings as well as other accumulated data point towards a reinterpretation of nervous system functioning in more complicated terms. For example, it appears that the orienting response and habituation are phenomena which have characteristics that are dependent upon the physiological system being studied. These separate systems may also be characterized in terms of their degree of interaction with higher neural centers. Relevant to these results and the present discussion are current notions in arousal theory. Here again research has shown physiological systems to be quite independent. Of particular interest is the fact that investigators in this area have also failed to find any relationship between autonomic, electrocortical, and behavioral measures. Such data lend credence to the results of this investigation as well as their interpretation.

With regard to the terminal orienting response (TOR), it appeared that the GSR-TOR may be a measure of the ability of the organism to conceptualize time. The EEG-TOR, however, seems to be somewhat independent of the autonomic measure thereby casting doubt as to its validity as a measure of the time binding capacity of the organism. It is suggested that the EEG-TOR may be related to quite different parameters than the GSR-TOR.

The failure of the spectral analysis to show any decrease in the frequency of the dominant alpha activity is subject to a meaningful interpretation. The relatively little work which has been done in this area has shown decreases in the alpha range in situations quite conducive to a decrease in physiological as well as behavioral arousal. Since no evidence for the latter was apparent in the present study, it is felt that the decrease in the frequency of the dominant alpha activity may accurately reflect a decrease in behavioral arousal.

- 909 Orr, W. C., Hoffman, H. J., & Hegge, F. W. Ultradian rhythms in extended performance. Aerospace Medicine, 1974, 45, 995-1000.

Eleven healthy, young, male volunteers participated in an experiment which involved continuous monitoring of heart rate and performance on a complex vigilance task. Ss were instructed to continue in the experiment for 48 h or until they felt they could go no longer. All Ss completed at least 21 h and two went for 44 h. Heart rate and behavioral measures were subjected to complex demodulation analysis to determine the phase and amplitude characteristics of cyclic activity with a period in the range of $90 \text{ min} \pm 5 \text{ min}$. The primary findings were a rather marked increase in the amplitude of the 90 min rhythm, in both heart rate and performance measures, as the time on task increased, reaching their highest level near the end of the run. This response pattern was found in over three-fourths of the analyses done, and was independent of the total duration of the experiment. It is felt that this marked amplitude rise is indicative of a cumulative stress response. In most subjects, the heart rate response did appear to show some similarity of patterning with at least one of the behavioral measures. Only three Ss showed an obvious dissociation between heart rate and the behavioral responses. There was, however, greater concordance of response patterning among the behavioral measures.

- 910 Orr, W. C., & Stern, J. A. The relationship between stimulus information, reaction time, and cortical habituation. Psychophysiology, 1970, 7, 475-484.

This investigation was an attempt to study systematically the effects of uncertainty, or stimulus information, on habituation rate. Subjects were randomly assigned to one of three conditions varying in uncertainty. EEG alpha desynchrony duration, electrodermal conductance change, and reaction time were the dependent measures. The results showed uncertainty to have no significant effect on any of the neurophysiological measures. There was a significant effect on the reaction time measure. There was no significant correlation between the EEG and electrodermal response measures, nor was there any correlation between either of these measures and reaction time. Results indicated that habituation could occur in the presence of cortical and behavioral arousal. It was concluded that information may be most meaningfully measured behaviorally and that habituation parameters are dependent upon the physiological system being measured.

- 911 Osborne, K., & Gale, A. Bilateral EEG differentiation of stimuli. Biological Psychology, 1976, 4, in press.

The EEG of both right and left hemispheres was monitored while subjects were presented with words, music, arithmetical problems and abstract pictures, (15 trials of each treatment, 9 sec per trial). The left side of the brain was most activated during presentation of words and arithmetic, whilst the right side of the brain was most activated during the presentation of music. In addition, the right side was more activated during exposure to arithmetic than to words. The pictures were not differentiated by either side of the brain and it is possible that they had the effect of deactivating or relaxing the subject.

- 912 Oswald, I. The EEG, visual imagery and attention. Quarterly Journal of Experimental Psychology, 1957, 9, 113-118.

Desynchronization of the E.E.G. during thinking occurs when difficulty arises. It is further recognized that difficulty of itself is the common precipitant of visual imagery in thinking. It is therefore proposed that suppression of the alpha rhythm may be explicable solely in terms of mechanisms controlling alertness, without reference to visual imagery. It is recognised that, of the human senses, vision is that which, when stimulated, most readily raises the level of attention.

In conclusion it is necessary to consider the theoretical premises of the belief that there exists an association between the E.E.G. and imagery. These are: (1) That thinking proceeds by the manipulation of images, as Short (1953) seems to believe. (2) That there exist imaginal types.

The first premise is one, the popularity of which has considerably decreased in the last 50 years and would be contested by many, e.g. Woodworth (1915). Humphrey (1951) has reviewed much of the experimental work on this problem.

The second premise is also one which has been doubted. Vernon (1937) wrote, "the evidence for clear-cut visual, auditory, kinaesthetic and verbal types is excessively small." Humphrey (1951) has referred to "the outmoded doctrine of imaginal types."

It is suggested that on both theoretical and experimental grounds, the claim that there exists a correlation between imagery and the E.E.G. merits scrutiny and re-evaluation.

- 913 Oswald, I. Experimental studies of rhythm, anxiety and cerebral vigilance. Journal of Mental Science, 1959, 105, 269-294.

Initially, a volunteer who had been subjected to very intense, irregular electric shocks, rapidly went to sleep one day when the shocks were less strong than he expected.

Further volunteers, who received regular, strong, electric shocks also went to sleep. Habituation of the galvanic skin response, and feelings of derealization occurred. Other subjects were subjected to the difficult task of listening for brief tones at the lower limit of audibility, occurring at regular intervals. Again there was an insistent tendency for sleep to appear over each session as a whole and for EEG sleep signs to occur between each stimulus-response, coming and going at, e.g. 3-second intervals.

Further experiments were carried out in which, for periods of an hour, subjects moved rhythmically to loud jazz music. Once again, EEG sleep signs appeared for long periods, even though movement continued. The quality of the latter tended to become impaired however. Once again EEG signs, as of fluctuation between alertness and sleep, at the rate of movement, were seen. Sleep appeared during movement to the loudest and most violent music, but most markedly when a sweet clarinet solo followed. Also when clapping and cheering helped the subject's escape to a dream-world.

In the experiments, the respiration tended to synchronize with the movement rhythm. Jazz rhythms occasionally caused hyperventilation. Characteristic differences between sleep and alertness were apparent in the shape of the respiratory curve.

Head's term "vigilance" was considered especially suitable to denote the varying cerebral states revealed by the EEG, especially when such variations were very rapid, or were localized to the rolandic areas, or even to the rolandic area contralateral to the hand in use. The hypothesis that the changes seen in these areas are related to proprioceptive afferents, was not supported.

- 914 Oswald, I. The human alpha rhythm and visual alertness. Electroencephalography and Clinical Neurophysiology, 1959, 11, 601-602. (Abstract)

The blocking of the human alpha rhythm has been believed on the one hand to be a part of general "arousal" or, alternatively, to be related specifically to visual activity.

Thirteen subjects listened with eyes open for a faint tone preceded by a regularly recurring warning signal. Initially no alpha rhythms were seen. Eventually alpha rhythms were more or less continuous. During an intermediate stage, in five subjects, alpha rhythms appeared at the times of intent auditory alertness. The alpha rhythm was accompanied by loss of ocular fixation and accommodation.

It is proposed that alpha blocking represents increase of specific visual alertness which may be but one component of general arousal. Specific auditory alertness may be accompanied by reciprocal inhibition of visual functions, at the periphery, during transmission, and centrally.

- 915 Oswald, I. Sleeping and waking: Physiology and psychology. Amsterdam & New York: Elsevier, 1962.

Among the topics discussed in this book are:

Sleep and consciousness

The cerebral cortex

Vigilance

Sleep in different species

The physiological basis of human sleep

Subcortical regulation of human sleep

Consciousness, baroreceptor impulses and respiration

The carotid sinus and human sleep-reactions

Corticofugal influences on the human reticular formation

The decline of cerebral vigilance

Reaction time and sensory threshold

Sensory discrimination

Memory and sleep

Movement in sleep

Muscular tonus and vigilance

Momentary episodes of sleep

Denials of having slept

Attention and imagery

Attention

Attention by control at the periphery and in transmission

Central mechanisms of attention

What evokes and directs attention

Imagery

Environmental uniformity

Images are constructions derived from hidden meaning

"Meaning" behind the conscious event

Images with effort and with relaxation

Summing-up

Some physiological functions

Changes with sleep

The respiration

The need for sleep

Rhythms and cycles

916 Oswald, J. The experimental study of sleep. British Medical Bulletin, 1964, 20, 60-64.

Sleep and wakefulness, regulated as they are by brainstem mechanisms, are not to be thought of as dichotomous but as extending along one continuum. Shifts in the direction of sleep can be both brief and frequent, with consequent effects upon behaviour.

The study of thinking and other activities during conditions of sleep and drowsiness has been rather neglected. Two principal kinds of sleep are now recognized, one of which is particularly related to dreaming.

- 917 Oswald, I., Taylor, A. M., & Treisman, M. Cortical function during human sleep. In G. E. W. Wolstenholme & M. O'Connor (Eds.), The nature of sleep, Boston: Little, Brown, 1960.

It would appear from these results that complex auditory discriminations can occur in the sleeping human subject (in sleep as deep as, or deeper than, the C stage) prior to arousal as manifested by the K complex.

In addition the galvanic skin responses were recorded. When subjects were awake these responses habituated to zero, but the stimuli were going on ceaselessly and, when the subjects went to sleep, in some the responses came back. Galvanic skin responses were seen to occur far more often after the forward-played names than after the backward ones during sleep.

It may be pointed out that although these backward and forward-played names were identical total physical stimuli their pattern of loudness distribution in time had been altered. A name may be loud and abrupt in its onset and quiet and gradual in its offset. Something that comes on gradually is likely to be less arousing than something that comes on sharply. We therefore carried out experiments using patterns of tones of increasing loudness, alternating with similar patterns of decreasing loudness, the total duration of each being half a second. These were played at seven-second intervals and it was shown that this loudness distribution factor, with stimuli of this duration, could not account for our results.

The experiments support the view that the sleeping human brain can carry out discriminations of such a degree of complexity as to render it highly likely that the cortex continues to function during sleep, and that exciting signals from the cortex to the reticular formation play a major role in arousal.

- 918 Otto, D. A., Benignus, V. A., Ryan, L. J., & Leifer, L. J. Slow potential components of stimulus, response and preparatory processes in man. In J. E. Desmedt (Ed.), Progress in clinical neurophysiology. Vol. 1. Attention, voluntary contraction and event-related cerebral potentials. Basel, Switzerland: Karger, 1977.

This study was undertaken to elaborate slow potential patterns associated with the preparation for and execution of sustained motor response. Preparatory and holding intervals of varying length were used to examine the interaction of the contingent negative variation (CNV), the readiness potential (RP), and the late positive component (LPC) of the sensory evoked response. The topographical distribution of motor-related potentials at frontal, central, and parietal midline sites was also assessed in cued and non-cued response conditions.

A slow positive response-related component (PRC) was observed during sustained button-pressing in the absence of external stimuli. When sustained motor response was superimposed on a CNV-eliciting interval, a decrement in negativity was observed. The CNV, RP, LPC, and PRC appear to summate linearly in complex slow potentials recorded on the scalp.

A multiple regression model was constructed to evaluate the contribution of CNV, RP, LPC, and PRC components to observed waveforms. The model provided a remarkably accurate approximation of empirical waveforms and accounted for 68-86% of the variance in observed data. Results suggest that the CNV and RP contribute differentially to slow potentials over different parts of the brain and probably reflect separate generator mechanisms. The model thus offers a promising method for teasing apart the functional components of complex event-related potentials of the brain.

- 610 Otto, D. A., & Leifer, L. J. The effect of modifying response and performance feedback parameters on the CNV in humans. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 29-37.

The effect on the CNV of sustained and delayed motor response with the dominant and non-dominant hand in the presence and absence of visual performance feedback was studied in 15 male adults. Monopolar scalp recordings were obtained at Fz, Cz, Pz, and bilaterally over the motor hand area. Results indicated that the magnitude of the CNV was greater in the delayed than sustained response task, greater in the presence than absence of feedback, and greater over the motor hand areas contralateral to movement. Frontal CNV habituated in the sustained but not the delayed response task, which suggests that frontal negative variations in the former case signify an orienting response to novelty or uncertainty. The absence of habituation in the delay condition was interpreted in terms of the motor inhibitory function of frontal association cortex. Performance feedback appeared to enhance CNV indirectly by increasing the motivation of subjects. A multiprocess conception of CNV was proposed in which vertex-negative slow potentials reflect a multiplicity of psychophysiological processes occurring at a variety of cortical and subcortical locations in the brain preparatory to a motor or mental action.

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- 920 Papakostopoulos, D., & Cooper, R. Brain, spinal cord and autonomic changes before, during and after a planned motor action in man. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

Simultaneous multichannel recordings of brain activity and the activity of various motor and autonomic systems, from 12 Ss, have been analysed. The data have permitted inference about the spatio-temporal participation of the pyramidal, extrapyramidal and cerebellar systems before, during and after a planned motor action in man.

- 921 Papakostopoulos, D., & Fenelon, B. Spatial distribution of the contingent negative variation (CNV) and the relationship between CNV and reaction time. Psychophysiology, 1975, 12, 74-78.

Multichannel recording of scalp CNV (Contingent Negative Variation) and RT (Reaction Time) was carried out on 12 normal adult Ss in a fixed foreperiod RT experiment. Single trial responses were stored on digital tape and averaged off-line. Strict control over eye movement artifact was exerted through fixation techniques coupled with mechanical and electro-oculographic monitoring of movement. Analysis of single-trial data gave an intra-individual picture of correlation apparently in conflict with the across-Ss picture gained from averages. A rationalization is attempted of these results and some evidence is offered that in the individual S, a negative and probably nonlinear relationship holds between CNV amplitude and RT. Analysis of average data demonstrates the distribution of CNV across the scalp and shows a lack of correlation between CNV and RT in prefrontal areas, in contrast with that found in central-parietal areas. It is suggested that the CNV is an index of functionally different processes in these areas.

- 922 Papakostopoulos, D., & McCallum, W. C. The CNV and autonomic change in situations of increasing complexity. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 287-293.

In an experiment involving several levels of increased stimulus-response complexity, recordings were made of scalp CNVs, eye movements, electrocardiogram, skin conductance and potential changes and respiration. Both tonic and phasic autonomic changes were found to occur during the course of the experiment. The most notable feature was a tonic acceleration of heart rate, superimposed upon which was a temporary deceleration during the period of the CNV. Although changes in respiration pattern and electro-dermal activity were also noted, these were found to be independent of the heart rate changes and unrelated to CNV.

It is suggested that three distinct processes may be interacting in the efforts of the organism to meet specific environmental demands: (1) the basic level of autonomic functions such as the heart rate; (2) the level of general activation in response to the demands of a particular situation; and (3) the selective mechanisms which appear to underlie the CNV and the process of heart rate deceleration during the CNV.

The CNV appears to offer a readily quantifiable measure relevant to processes involved in the integration of cortical activation, autonomic change and performance.

- 923 Parasuraman, R. Response bias and physiological reactivity. Journal of Psychology, 1975, 91, 309-313.

Sixteen Ss were selected from a group of 30 adult males for low and high levels of physiological reactivity, as defined by several measures of electrodermal activity (EDA). They were subsequently tested on two occasions on a tone discrimination task in which confidence ratings were required. High EDA Ss discriminated a significantly greater number of tones, but this apparent superiority was not due to their superior sensitivity, but to a greater bias towards responding positively to signals. The results were discussed in relation to possible mechanisms mediating individual differences in response bias and physiological reactivity.

- 924 Parasuraman, R., & Davies, D. R. Response and evoked potential latencies associated with commission errors in visual monitoring. Perception and Psychophysics, 1975, 17, 465-468.

Eight male subjects performed a 40-min visual monitoring task in which they were required to detect the occasional dim flash from a background of brighter flashes. Response latencies associated with correct detections (CDs) and commission errors (CEs) were recorded, as were the peak latencies of evoked potential (EP) components averaged separately for each of the two response categories. Response latencies for CEs were significantly longer than those for CDs, and "late" EP component latencies (P_2 , N_2 , and P_3) associated with CEs were also significantly longer than component latencies associated with CDs. These results are discussed with reference to EP concomitants of decision processes and to various theories of monitoring behavior.

- 925 Parikh, N. I. A study of blood pressure and sinus arrhythmia as measures of mental load in a visual inspection task (Doctoral dissertation, The University of Oklahoma, 1971). Dissertation Abstracts International, 1971, 32, 311B-312B. (University Microfilms No. 71-17, 047)

This work describes the effect of a visual inspection task on sinus arrhythmia. A static inspection task was used, together with an auxiliary task consisting of responses to auditory signals. The inspection task consisted of identification of alphabetic, numeric and geometric errors in matrices of two sizes (5x5 and 7x7).

Four subjects performed the visual inspection task and the auxiliary auditory task. Three levels of types of errors were employed. Visual tasks of two different time lengths were performed. The total number of errors in the visual inspection task was selected at two levels.

The dependent variables measured were increase in systolic blood pressure, increase in diastolic blood pressure, and reduction in sinus arrhythmia, all measured as the change from resting to working levels of the variable. The important findings were: 1. Reduction in sinus arrhythmia can be used as a measure of mental load in a visual inspection task. 2. Reduction in sinus arrhythmia is the most sensitive physiological measure of the three used, followed by increase in systolic blood pressure and then increase in diastolic blood pressure. 3. Increase in systolic blood pressure is significantly affected by subjects and types of errors. 4. Increase in diastolic blood pressure is significantly affected by types of errors and total number of errors. 5. Reduction in sinus arrhythmia is significantly affected by subjects and inspection for alphabetic, numeric or geometric errors.

- 926 Parrot, J., & Baumstirler, Y. Evolution du clignement palpebral au cours de l'exécution prolongée d'une tâche d'attention visuelle soutenue: Distribution temporelle, relations avec d'autres variables physiologiques et avec la performance. [Evolution of eyeblinks during the prolonged performance of a sustained visual attention task: Temporal distribution, relationships with other physiological variables and with performance.] Actes du Troisième Congrès de la Société d'Ergonomie de Langue Française, Bruxelles: Presses Universitaires de Bruxelles, 1968, 50-56.

This study examined the relationship between eyeblinks and the physiological variables of heart rate and rectal temperature on the one hand, and performance on the other hand. Seven out of 10 subjects showed a significant positive correlation between poor performance and blink rate. When poor performance was further analyzed, eight significant correlations were found between blink rate and overly long responses and five between blink rate and erroneous responses.

- 927 Patkai, P. Interindividual differences in diurnal variations in alertness, performance, and adrenaline excretion. Acta Physiologica Scandinavica, 1971, 81, 35-46.

Subjects classified as habitual morning vs. evening workers on the basis of their answers to a questionnaire, were compared with regard to day-time variations in catecholamine excretion and performance. Adrenaline excretion in morning workers was highest in the morning and decreased gradually during the day, while evening workers showed nearly constant excretion values. The performance of morning workers did not vary during the day, while evening workers showed a steady improvement, performing best in the evening. In addition, a significant difference between the two groups was found in the personality dimension of extraversion-introversion, showing that evening workers were more extravert and morning workers more introvert. The constancy of individual diurnal rhythms and their relations to personality traits, are discussed.

- 928 Patkai, P., Frankenhaeuser, M., Rissler, A., & Bjorkvall, C. Catecholamine excretion, performance, and subjective stress. Scandinavian Journal of Psychology, 1967, 8, 113-122.

Psycho-endocrine relations were explored in 52 students exposed to moderately stressful psychological tests demanding selective attention. Subjects with high excretion rates of adrenaline performed better during the entire stress session than did subjects with low adrenaline excretion. The level of subjective stress increased consistently throughout the session in subjects with low excretion rates of adrenaline, while it remained relatively constant in subjects with high adrenaline excretion. No consistent relationship could be demonstrated between noradrenaline excretion and the psychological variables. Possible effects on the catecholamine-excretion patterns of factors such as severity and duration of the stress are discussed.

- 929 Paul, D. D., & Sutton, S. Evoked potential correlates of response criterion in auditory signal detection. Science, 1972, 177, 362-364.

The amplitude of a late positive component of the average evoked potential recorded from the human scalp varied systematically as a function of the observers' response criterion as defined within the context of signal detection theory. With signal intensity invariant, the P_3 component of the evoked potential increased monotonically with increasing strictness of the criterion. The results are viewed as supporting the signal detection theory approach to the analysis of discrimination behavior as well as providing further evidence of the sensitivity of P_3 to the manipulation of psychological variables.

- 930** Pavlidis, G. T. Bibliographic survey of eye movements: 1849-1976. JSAS Catalog of Selected Documents in Psychology, 1976, 6, 101. (Ms. No. 1349.)

Eye movement research has been a major field of inquiry in psychology, behavioral sciences, and other disciplines (e.g., biomedical electronics). The number of publications on eye movements has been expanding rapidly over the years. This expansion makes it difficult and time consuming to keep up with the literature, especially since it is reported in a wide variety of journals. The bibliography includes more than 2,000 references. It aims at comprehensively covering the articles and books published on eye movement from the beginning in 1849 through 1975, as well as some articles published early in 1976. Unlike previous surveys, this one is not confined to specific eye movement areas. Many aspects of eye movement research, including the following, are covered: saccadic, pursuit, vergence, miniature, compensatory, tortional and nystagmoid eye movements, methods of recording, and motor and control characteristics; relation of eye movements to visual perception, visual acuity, laterality, ocular dominance, attention, information processing, picture scanning, driving, piloting, reading, dyslexia, language use and comprehension, sleeping, dreaming, EEG, evoked potentials, hypnosis, meditation, alcohol, drugs, and anxiety; and the neurophysiology and the diagnostic value of eye movements (e.g., for some ocular anomalies, personality, and mental illness). The books on eye movements are listed separately and a brief, informative description of their contents is given.

- 931** Payne, D. T., Parry, M. E., & Harasymiw, S. J. Percentage of pupillary dilation as a measure of item difficulty. Perception and Psychophysics, 1968, 4, 139-143.

Compared 4 measures of difficulty of mental multiplication items: percentage of pupillary dilation, latency of solution, number of correct responses, and judgment of item difficulty. Sixteen multiplication problems, classified into 4 levels of difficulty, were presented visually to 13 Ss, who verbalized their solutions to the problems. Analyses of variance and correlation coefficients were computed. It is concluded that all 4 measures of difficulty were useful but that judgment of difficulty and latency of solution were better measures of item difficulty than were the other 2. Pupillary dilation and information processing are discussed.

- 932** Pearson, D. W., & Thackray, R. I. Consistency of performance change and autonomic response as a function of expressed attitude toward a specific stress situation. Psychophysiology, 1970, 6, 561-568.

A persistent problem in stress research has been that some individuals may show impairment, while others show improvement or no change in performance under stress. Attempts to relate this variance in performance to general anxiety or other personality variables have generally not been too successful. Based upon responses to a fear of shock item in an attitude questionnaire, Ss were classified as "high fear of shock" or "low fear of shock" types. Half of the Ss in each group were assigned a perceptual-motor task; the others were assigned a cognitive-interference task. After training, all Ss were informed that they would be required to maintain their training performance levels in a situation in which they would be shocked if performance declined. Performance and heart rate measures taken during training were compared with the same measures taken under the threat-of-shock conditions. Results indicate significant differences between groups in both performance and physiological activity with "high fear of shock" Ss exhibiting relatively greater performance impairment and increased heart rate.

- 933 Peavler, W. S. Pupil size, information overload, and performance differences. Psychophysiology, 1974, 11, 559-566.

As a test of the hypothesis that pupil dilation during performance is partially due to a task related anxiety component, pupillary patterns were measured while subjects (Ss) processed digit strings of various lengths for immediate recall. Information overload resulted in a leveling of the dilation pattern which suggested a momentary suspension of processing effort. In addition, significant correlations were observed between individual differences in pupil size and recall performance.

- 934 Pendergrass, V. E., & Kimmel, H. D. UCR diminution in temporal conditioning and habituation. Journal of Experimental Psychology, 1968, 77, 1-6.

A study was done to compare diminution of the GSR to a 1,000-cps tone during regular and irregular temporal spacing of the tones, and to determine the influence of a judgment task on the GSR under these conditions. One group received a 90-db. tone every 40 sec for 40 trials, while one group received the series of 40 tones at irregular temporal intervals of 20, 30, 40, 50, or 60 sec. In addition, half of the Ss in each group were required to judge the intensity of the UCS after each stimulus presentation. No evidence was found for temporal conditioning in the nonjudgment groups, although there did appear to be anticipatory conditioned responding in the judgment groups. It was suggested that the task facilitated the development of anticipatory responding in temporal conditioning, and as a consequence also resulted in smaller GSRs to the tone. In habituation, however, the task appeared to disrupt the ongoing process, and eliminated response attenuation. Increased arousal or attention induced by the task and/or by S's perception of regular spacing was proposed as a possible explanation of these effects.

- 935 Perret, E. Le probleme psychologique et physiologique de la vigilance. [Psychological and physiological problems of vigilance.] Revue de Medecine Preventive, 1961, 6, 23-31.

Diverse psychological hypotheses have been offered as a basis of vigilance experiments to explain the fall in performance observed in these tasks. Recent findings from the physiology of the nervous system, although concerned with other areas than vigilance, are related to the reported experiments.

- 936 Perret, E., & Grandjean, E. Effects of monotony on psychophysiological functions. Ergonomics, 1964, 7, 368. (Abstract)

Six subjects sat without doing anything in a room with constant noise and illumination for two hours. This was considered a monotonous situation, since its sensory as well as psychomotor aspects were held fairly constant for its whole duration. In the control situation the subjects were asked to translate short stories for two hours, an activity which could be considered non-monotonous. In addition, the possible effects of different functional states of the autonomic nervous system were studied by giving the subjects either a large or a light meal just before the sessions.

Before and after every session critical flicker frequencies were simple visual reaction times were measured, and during the session spontaneous activity, heart rate and respiratory frequency, galvanic skin resistance and skin temperature were recorded.

The spontaneous activity and the visual reaction times remained constant in the four experimental conditions. The critical flicker frequencies were decreased significantly; heart rate and respiratory frequency also decreased, but not significantly. Galvanic skin resistance was decreased considerably and skin temperature was increased, but these two alterations seem to be due to technical artefacts.

- 937 Ferry, H. W., Jr., & Childers, D. G. The human visual evoked response: Method and theory. Springfield, Ill.: Thomas, 1969.

In the preceding chapters, we have attempted to describe in reasonable detail some of the advantages and disadvantages of the VER as a tool relative to some older investigative techniques of neural functioning in the visual system. It is difficult to determine if the most appropriate picture of the VER has been given. It is conceivable that, through our cautiousness, the disadvantages have been emphasized at the expense of the advantages. If so, we have inadvertently done the VER and its research and clinical potential a disservice since we believe many of the disadvantages are due to the relative newness of the method.

Utilization of the full potential of the VER requires greater development of the methodology, along with the establishment of more precise parameters and quantitative analyses and better theories of the functioning of neural populations. The early and rapid developments in all three of these interdependent areas and the establishment of a number of perceptual correlates of the VER suggest that the potential is great indeed. The EEG initially was hailed somewhat picturesquely as providing a window to the brain. We believe that the VER will prove to be a much more useful and a much clearer window.

- 938 Pesta, T. Lernleistung und aktivierung bei intraindividuell variabler akustischer stimulation. [Brain activity and performance during intraindividually variable acoustic stimulation]. Zeitschrift für Experimentelle und Angewandte Psychologie, 1973, 20, 107-116.

An intraindividual change in the activity level, lasting for a short time, was induced by using a sinusoidal tone of 1000 c.p.s., oscillating continuously in 5 sec intervals, in an intensity range of 30 to 60 db; this change affected the learning performance and the cortical alpha-activity.

Meaningless syllables, presented while the intensity of sound increased, were learned significantly better than when the intensity decreased, when the duration of the experiment increased. Thereby, the variations in the intensity of sound caused statistically certain frequency variations in the area of the alpha-activity of the brain: as the intensity increased, there was reduced alpha-activity; on the other hand, the alpha-activity increased with decreasing intensity. The relation between the change in EEG and the enhanced performance was $r = 0.79$.

The results were checked and confirmed in a second experiment.

Accordingly, small changes of short duration in the activity level could be considered as the decisive variable in the control of the individual learning performance.

- 939 Peters, J. F., & Knott, J. R. CNV and post-response negativity with stressful auditory feedback. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

The data furnish some support for Weinberg's findings of increase in post- S_2 negativity under feedback conditions. There is also further evidence of sex differences in SP activity related to stress, which in this case continues beyond the immediate preparatory interval. However, the usual CNV difference in stress related to sex did not appear. This may be due to a sampling error, or a difference in paradigm.

CNVs were elicited from 2 groups of Ss under feedback and non-feedback conditions. A significant increment in post S_2 negativity was seen on those trials in which feedback was expected, largely contributed to by female Ss.

- 940 Peters, J. F., Knott, J. R., & Hamilton, C. E. Further thoughts on measurement of 'the' CNV. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

Of the five methods of CNV amplitude measurement presented, all but the one based on the peak positivity to S_1 (PPA) reflected the expected response v. non-response difference (Irwin et al., 1966). Absence of this difference in the PPA measure is quite possibly due to intra-subject variability in the size of peak positivity, as evidenced by the large standard deviation in this measure and in the area measure which incorporated the EP to S_1 (A_1). Measures of this nature are confounded by the inability to determine whether the CNV or the evoked response varied with the paradigm. Such an objection is not uncommon in evoked response research (Friedman et al., 1973). However, in cases where the CNV never recrosses the baseline in the S_1 - S_2 interval, this method is apparently the only alternative!

- 941 Peters, J. F., Knott, J. R., Miller, L. H., Van Veen, W. J., & Cohen, S. I. Response variables and magnitude of the contingent negative variation. Electroencephalography and Clinical Neurophysiology, 1970, 29, 608-611.

When subjects in a fixed fore-period reaction time task are presented with a repetitive stimulus that is terminated by the manual response made to it, the contingent negative variations following the warning stimulus will be of greater magnitude than when a single stimulus, over which the subject has no control, is used. It is suggested that different levels of motivation are involved in these two conditions.

- 942 Pettyjohn, F. S., McNeil, R. J., Akers, L. A., & Faber, J. M. Use of inspiratory minute volumes in evaluation of rotary and fixed wing pilot workload. In K. E. Klein (Ed.), Methods to assess workload. AGARD Conference Preprint, No. 216, 1977. (Available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.) (Abstract)

The inspiratory minute volume (IMV) is shown to be correlated with the recognized stress and workload periods of helicopter and fixed wing flight profiles examined. The trends indicate the actual flight under "cruise" or operational conditions produces a consistent twofold increase in inspiratory volume.

Review of findings and clinical correlation will be provided. Continued studies using heart rate, respiratory rate, and indirect calorimetry will be presented.

Use of the IMV is considered a valuable clinical tool in the assessment of aircrew workload.

- 943 Pfefferbaum, A., Buchsbaum, M., & Gips, J. Enhancement of the average evoked response to tone onset and cessation. Psychophysiology, 1971, 8, 332-339.

Auditory average evoked responses (AERs) produced by tone onset (ON responses) and tone cessation (OFF responses) were studied in 14 normal adult subjects. When short (500 msec) tone bursts were presented widely spaced (2500 msec between tones), ON responses were large, in contrast to OFF responses, which were less than one-third their size. But when long tones (2500 msec) were succeeded by brief (500 msec) silences, OFF and ON responses were comparable in size. In addition to this observed effect of the ratio of the percent of time the tone was on to the percent of time the tone was off, control experiments suggested that increased duration of preceding interval, unexpectedness of stimulus occurrence, and decreased mean frequency of stimulus presentation all increase the amplitude of both OFF and ON responses. OFF responses were found to be more sensitive to stimulus spacing effects than ON responses.

- 944 Picton, T. W., & Hillyard, S. A. Human auditory evoked potentials. II: Effects of attention. Electroencephalography and Clinical Neurophysiology, 1974, 36, 191-199.

Attention directed toward auditory stimuli, in order to detect an occasional fainter "signal" stimulus, caused a substantial increase in the N₁ (83 msec) and P₂ (161 msec) components of the auditory evoked potential without any change in preceding components. This evidence shows that human auditory attention is not mediated by a peripheral gating mechanism. The evoked response to the detected signal stimulus also contained a large P₃ (450 msec) wave that was topographically distinct from the preceding components. This late positive wave could also be recorded in response to a detected omitted stimulus in a regular train and therefore seemed to index a stimulus-independent perceptual decision process.

- 945 Picton, T. W., Hillyard, S. A., Galambos, R., & Schiff, M. Human auditory attention: A central or peripheral process? Science, 1971, 173, 351-353.

The click-evoked electrical responses of the human cochlear nerve were recorded from the external ear canal concurrently with the cortical evoked potentials from the scalp. Paying attention to the clicks during a discrimination task resulted in a highly significant enhancement of the cortical response but no change in the cochlear nerve response. Hence no evidence was obtained for the operation of a peripheral gating mechanism during attention in man.

- 946 Picton, T. W., Hillyard, S. A., Krausz, H. I., & Galambos, R. Human auditory evoked potentials. I: Evaluation of components. Electroencephalography and Clinical Neurophysiology, 1974, 36, 179-190.

Fifteen distinct components can be identified in the scalp recorded average evoked potential to an abrupt auditory stimulus. The early components (I-VI) occurring in the first 8 msec after a stimulus represent the activation of the cochlea and the auditory nuclei of the brainstem. The middle latency components (N o , P o , N a , P a , N b) occurring between 8 and 50 msec after the stimulus probably represent activation of both auditory thalamus and cortex but can be seriously contaminated by concurrent scalp muscle reflex potentials. The longer latency components (P₁, N₁, P₂, N₂) occurring between 50 and 300 msec after the stimulus are maximally recorded over fronto-central scalp regions and seem to represent widespread activation of frontal cortex.

- 947 Pollen, D. A., & Trachtenberg, M. C. Some problems of occipital alpha block in man. Brain Research, 1972, 41, 303-314.

(1) Experiments were carried out in 10 human subjects to try to evaluate the relative importance of visual attentiveness, a patterned visual input, oculomotor control functions and mental effort with respect to attenuation of the occipital alpha rhythm.

(2) Alpha rhythm was almost completely blocked when alert subjects were involved in reading even when the near triad of accommodation had been experimentally eliminated or minimized. Thus 'visual attentiveness' alone is sufficient to block the alpha rhythm.

(3) Visual sensory detail alone was not a sufficient stimulus to block the alpha rhythm, even though accompanied by saccadic movements. Rather it is the attentiveness to the detail which blocks the alpha rhythm.

(4) Progressively more difficult mental effort, as in serial multiplication, eventually led to an attenuation of the alpha rhythm. A sustained type of mental effort such as blindfold chess led to an initial attenuation of the alpha rhythm followed by a gradual return after the first few minutes of play to resting eyes closed levels. However, during periods in which subjects claimed that they required exceptional increases in mental effort, the alpha rhythm again became attenuated. The possible significance of alpha block is discussed.

- 948 Poock, G. K. Information processing vs pupil diameter. Perceptual and Motor Skills, 1973, 37, 1000-1002.

The effects of information processing on pupil diameter were investigated. Results showed that pupil diameter was significantly greater than a baseline diameter when Ss were required to process information at 75 and 100% of their maximum capacity. However, when Ss were required to process information at a rate above their maximum capacity, the pupil constricted significantly below the baseline diameter. Pupil diameter may be a parameter which would identify points in time where mental overload occurs in a worker's job, and therefore identify areas of the job which should be redesigned if one wished to reduce mental overload.

- 948 Poock, G. K., & Noel, C. E. Effects of layout of workplace on pupillary diameter. Perceptual and Motor Skills, 1975, 40, 304.

In the compatible stimulus-response arrangement, the pupillary diameter increased with stimulus presentation rate up to a rate of 3 bits per sec at which point the pupil constricted below the baseline level. Likewise the constriction point for the noncompatible condition was 2.4 bits per sec. Application of the Wilcoxon matched-pairs signed-ranks test showed the presentation rate at the time of overload in the noncompatible arrangement to be significantly lower than in the compatible arrangement ($p < .025$).

- 950 Poock, G. K., Tuck, G. A., & Tinsley, J. H. Physiological correlates of visual monitoring. Perceptual and Motor Skills, 1969, 29, 334.

Investigated correlations between heart rate, skin temperature, skin resistance, systolic blood pressure, diastolic blood pressure, and pulse pressure with visual monitoring performance. Systolic blood pressure and skin temperature provided a significant multiple correlation ($p < .05$). Skin temperatures averaged approximately 2°F higher when signals were detected than when missed.

- 951 Poon, L. W., Thompson, L. W., & Marsh, G. R. Average evoked potential changes as a function of processing complexity. Psychophysiology, 1976, 13, 43-49.

Electrophysiologic potentials (averaged evoked potentials (AEP) and contingent negative variation (CNV)) recorded during simple recognition and discriminative responses to tachistoscopically presented letter-pair stimuli showed a systematic shift toward greater overall positivity (smaller CNVs and larger late positive components) during increased processing load. In addition, more positive P2 components were found in the right as compared to the left hemisphere during simple recognition, and this asymmetry was enhanced during the more complex processing condition.

- 952 Poon, L. W., Thompson, L. W., Williams, R. B., Jr., & Marsh, G. R. Changes of antero-posterior distribution of CNV and late positive component as a function of information processing demands. Psychophysiology, 1974, 11, 660-673.

The topographic distribution of the amplitudes of the contingent negative variation (CNV) recorded along the midline at the anterior, central, and posterior regions of the human scalp varied as a function of type of information processing demanded. A parietal-dominant CNV was found when active problem-solving behavior was required. A central-dominant CNV was evident in a disjunctive reaction time task. The results are interpreted as evidence supporting a model of cortical function which predicts shifts in cortical involvement as a function of type of task demands. A late positive component (LPC) of the average evoked potential was also found to vary as a function of stage of learning, recording sites, and an attitudinal dimension measured by Rotter's internal-external locus of control scale.

- 953 Porges, S. W. Heart rate variability as a predictor of attentional performance. Psychophysiology, 1971, 8, 273. (Abstract)

The relationship between resting heart rate (HR) variability and subsequent performance on a reaction time (RT) task was investigated in two groups of 18 male college students. One group had a fixed preparatory interval (PI) of 16 sec while the second group had PIs which varied among 16, 22, and 28 sec. All Ss received 2 sessions of 10 trials separated by a 2 min rest period. The first session was used as practice to adapt Ss to the experimental situation. The resting level HR variability for each S was defined as the variance of 25 beats one minute into the rest period. A factorial design was used in which resting level HR variability (high, mid, and low) was nested under the factor of groups.

When the PIs were randomly varied, significant differences ($p < .005$) existed among the three levels of resting HR variability and RT performance during the second 10 trials, while no significant relationship existed when the PI was held constant. Moreover, the analysis of variance for HR variability indicated no trial or variability level-by-trial effects. A correlation between the individual S's HR variability during the resting period and his mean RT performance during the second session was significant for the variable PI group ($r = -.711$, $n = 18$, $p < .001$). The data indicated that individuals who exhibited a more variable resting HR had faster RTs, thus supporting the hypothesis that RT performance may be predicted from HR response patterns.

- 954 Porges, S. W. Respiratory and heart rate indices of reaction time (RT) signal and control nonsignal stimuli were investigated in male college students. The two conditions produced differential respiratory and HR responses. Heart rate accelerated in response to the warning and respond signals. The HR acceleration to the respond signal was concordant with increases in HR variability, respiratory frequency and amplitude. In contrast to the mean HR, which did not change in anticipation of the respond signal, respiratory frequency increased and respiratory amplitude and HR variability decreased. In response to the nonsignal stimuli HR decelerated. Mean HR variability prior to the trial onset and mean magnitude of the reduction of HR variability in anticipation of the respond signal were highly significant correlates of RT when the preparatory interval (PI) was of variable duration. When the PI was of fixed duration HR variability was not correlated with performance. Although HR decelerated prior to the respond signal, the magnitude of deceleration was not related to performance. The data support a two component hypothesis of attention: the first, a phasic reflexive response dependent upon the specific stimulus change and characterized by a directional HR response; the second, a tonic instrumental response related to attentional performance and characterized by a decrease in HR variability.

- 885 Porges, S. W. Heart rate variability and deceleration as indexes of reaction time. Journal of Experimental Psychology, 1972, 92, 103-110.

Heart rate indexes of reaction time (RT) were investigated in male college students. The Ss were required to perform one of two tasks, either to respond as rapidly as possible following the termination of an extended visual warning or to merely observe the same temporal sequences of nonsignal visual stimuli. In the RT groups following the onset of the warning signal, heart rate variability increased; in anticipation of the termination of the preparatory interval (PI), heart rate variability decreased; and following the onset of the respond signal, both heart rate and heart rate variability increased. In the control groups, there were no significant changes in either heart rate or heart rate variability. In the RT group presented with a schedule of variable PIs, the mean magnitude of heart rate variability reduction in anticipation of the termination of the PI and the mean pretrial heart rate variability were significantly correlated with RT. When the PI was of a fixed duration, the heart rate variability measures were not significantly related to RT.

- 886 Porges, S. W. Heart rate variability: An autonomic correlate of reaction time performance. Bulletin of the Psychonomic Society, 1973, 1, 270-272.

Resting level heart rate variability was measured and correlated with subsequent reaction time performance in male college students. The Ss were required to respond as rapidly as possible following an extended visual warning signal of either fixed or variable duration. Resting level heart rate variability was related to reaction time only in the variable-foreperiod condition. The data are interpreted as illustrating the sensitivity of the relationship between heart rate variability and reaction time to slight changes in task demands.

- 887 Porges, S. W., & Raskin, D. C. Respiratory and heart rate components of attention. Journal of Experimental Psychology, 1969, 81, 497-503.

The respiratory and heart rate (HR) components of attentive observation to external stimuli (tone or light) and to an internal stimulus (Ss' own HR) were investigated in male college students. The Ss were required to either estimate their HRs, estimate the rate of a series of intermittent tones, count light flashes, or watch a light flash. The various tasks produced no differential effects on respiration, but across tasks there were significant increases in frequency and decreases in amplitude of respiration. Mean HR decreased across trials, and all tasks except watching the light produced significant decreases in HR variance. The HR response pattern during the first 10 sec of each trial differentiated between the groups: HR accelerated for internal observation and decelerated for external observation.

- 888 Porjesz, B., & Begleiter, H. The effects of stimulus expectancy on evoked brain potentials. Psychophysiology, 1975, 12, 152-157.

The effects of self-generated expectancy of stimulus content on the visual evoked potential to physically identical stimuli were studied in college students. The subject set up his own internal expectancy by choosing to see either a bright or dim flash. When a bright or dim flash was anticipated, the potentials evoked by a medium stimulus intensity resembled the responses elicited by an actual bright or dim flash, respectively. Significant differences in visual evoked potential amplitude were obtained between identical medium intensity stimuli depending on the stimulus intensity expected, despite the constant physical properties of the stimulus. The results suggest that a subject's expectancy of certain physical parameters of a stimulus are as important in determining the resultant visual evoked potential as the actual physical features of the stimulus.

- 880 Posner, M. I., Klein, R., Summers, J., & Buggie, S. On the selection of signals. Memory and Cognition, 1973, 1, 2-12.

In a previous paper, it was argued that alertness, selectivity (set), and processing capacity (consciousness) could be identified and studied as separate components of attention. The current paper develops this theme by showing that alertness does not affect the buildup of information within the memory system but only the rate at which a later system responds to that information. Thus, in standard reaction-time tasks, increased alertness produces a reduction in reaction time but no decrease in errors. In contrast, providing a model of the signal the S is to process improved both speed and accuracy. The presence of a model of what the S is to process varies the vertex neural response to that specific signal as compared to a mismatching signal in the first 200-300 msec after its presentation. Three accounts of this effect are: speeded processing of a matching stimulus, habituation of the electrical response to a matching stimulus, and prolonged or enhanced processing of a mismatch. Evidence favors the first of these explanations, but the other two cannot be dismissed as possible contributors to this effect.

- 880 Poulton, E. C., Hitchings, N. B., & Brooke, R. B. Effect of cold and rain upon vigilance of lookouts. Ergonomics, 1965, 8, 163-168.

Sixteen men performed lookout duties twice at sea in winter on an open bridge, once in the Arctic (mean temperature 28° F) and once in a more temperate climate (mean 37° F) in counterbalanced order. The 2 signal sources were separated by an angle of 75° and presented 7 signals each in an irregular order and at irregular intervals during a 30-minute watch. The lookout had to respond as soon as he saw a signal. There were reliably more response times of 2.0 seconds or longer in rain than in the cold ($p < .01$). There was a reliable increase in the number of long response times during the watches in the cold ($p < .01$) accompanied by a mean fall in oral temperature of 1.2° F.

- 881 Preston, F. S. Time zone disruption and sleep patterns in pilots. Transactions of the Society of Occupational Medicine, 1970, 20, 77-86.

The author reports on studies of sleep patterns of commercial airline pilots flying on long routes and on physiological effects and changes in physical performance resulting from disruption of circadian rhythm. Details are given of sleep/work cycles and of subjective assessments by pilots of their own physical state during long periods of duty. The author interprets his findings and considers methods of maintaining the health and efficiency of aircrews flying long routes, including provision of sound-proofed and air-conditioned hotel accommodation, proper meals at the right time, and exercise, and possibly facilities for recreation and, in special circumstances, under strict medical control, administration of sleep-inducing drugs.

- 882 Provins, K. A. Environmental heat, body temperature and behaviour: An hypothesis. Australian Journal of Psychology, 1966, 18, 118-129.

Recent experimental investigations of the relationship between environmental heat, body temperature and behaviour are briefly reviewed and an explanation of the findings is postulated using the concept of "arousal." Supporting evidence is drawn from neurophysiological studies on animals and field observations of people living under tropical conditions.

- 983 Provins, K. A., & Bell, C. R. Effects of heat stress on the performance of two tasks running concurrently. Journal of Experimental Psychology, 1970, 83, 40-44.

Twenty Ss performed a five-choice serial reaction time (SRT) task at each of two paces while watching for infrequent light signals from six different parts of the visual field in both cool (27° /15° C. dry bulb/wet bulb) and hot (40° /35° C. dry bulb/wet bulb) environmental conditions. An initially beneficial effect of heat on performance of the fast-paced SRT task was lost with continued exposure to heat, but no climatic effect was found on performance of the visual vigilance task. The results are discussed in terms of "arousal" and are considered to support the view that the effect of heat exposure on perceptual-motor performance is more directly related to body temperature than the climatic conditions.

- 984 Pushkin, V. N., Nersisyan, L. S., & Sinaiskii, M. I. Reoentsefalografiya kak integral'nyi metod registratsii psikhicheskoi napryazhennosti. [Rheoencephalography as an integral method of recording mental tension.] Zhurnal Vysshei Nervnoi Deyatel'nosti, 1970, 20, 655-658.

Presents the results of 2 exploratory studies, with 21 and 36 Ss, respectively, to determine the usefulness of rheoencephalograms (REGs) in detecting mental tension since "even brief intense mental activity produces such changes in cerebral circulation as to find its expression in REG parameters." The parameters, h_1 and the ratio $K_k = h_1/h_2$, where h_1 = height of REG wave and h_2 = height of the catarcotic tooth, appear utilizable for objective registration of mental tension. In addition, the simplicity of the recording and of its analysis, together with the clear-cut character of the data, furthers the possibility of utilizing the REG for defining degrees of mental tension and for resolving other questions connected with the rational organization of the work of the human operator.

- 985 Puttrich, O. Anforderung und Beanspruchung bei Industriellen Steuertätigkeiten unter Analogie-Experimentellen Bedingungen. [Requirements and strain in industrial control activity under analogical-experimental conditions.] Proceedings of a Symposium on Ergonomics in Machine Design, jointly organised by the Czechoslovak Medical Society I. E. Purkyne and ILO, Prague, 2-7 October 1967, ILO, Geneva, 1969, 1, 53-62.

Three typical situations of control action were created where signals were to respond to continuous events in certain circuits. These three situations differ in their requirement structures:

1. Concentrated observation of progress and control interference in events after signalling the end of the required operation (requirements as to observation, attention, understanding situations and prediction).
2. Observation of progress with responses at a certain moment but under restricted possibilities of anticipation.
3. Right response to the appropriate group of stimuli (choice experiments).

In the standard experiment the three control activities were performed, each with three levels of difficulty. The mental strain has been assessed using heart rate as a physiological indicator (continual recording). It has been shown that the first situation described imposes the highest requirements and produces the greatest strain.

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- 986 Ramsey, J. D., Halcomb, C. G., & Kassouny, M. Effects of cyclical temperature on vigilance performance. Lubbock, Texas: Texas Tech University, May 1972. (NTIS No. AD 748451)

Vigilance performance has been shown to be enhanced by numerous types of environmental changes. This study evaluates the effects of a cyclically changing temperature on monitoring behavior and physiological responses of man. Vigilance performance was not enhanced by the use of the variable temperature conditions of this study. Rather, the variable temperature in conjunction with a heavy food intake was shown to adversely affect both heart rate and vigilance task performance measures.

- 987 Ramsey, J. D., & Mortagy, A. Work performance under thermal stress. Lubbock, Texas: Texas Tech University, February 1971. (NTIS No. AD-721595)

This is a report on some of the recent and current work in the environmental chamber at Texas Tech University. We have an environmental chamber with programmable temperature capability between 36° F and 160° F, and relative humidity range between 10% and 98%.

Most of the studies have been oriented towards our Project THEMIS Research Contract entitled "Performance, Recovery and Man-Machine Effectiveness." Our major concern has been in terms of maintenance of performance, retarding performance decrement, and enhancement of recovery. Thus, we have been investigating rest pauses, work changes, work schedules, environmental changes, and other schemes to accomplish the above.

Specific studies discussed include: an investigation of variable temperature and diet effects on monitoring performance; an analysis of effects of localized heating of the head when performing simple motor and mental tasks in the cold; and a study of psychomotor task performance in the heat. Two additional investigations concerning vigilance task performance are currently in progress and are described herein. These studies represent different schemes of work and rest schedules as influenced by heat. Heart rate changes were also examined in some of the studies.

- 988 Raouf, A. A study of variations in the operator performance time and heart rate while performing a repetitive-paced task. Ergonomics, 15, 3, 16, 313. (Abstract)

Performance time variations within an operator and amongst a group of operators are known to exist. Some industrial workers have a faster pace of working than others. In situations where pace of work is machine controlled, all the workers are required to maintain the same speed of work. The workers, who, either are faster or slower than the set pace, perhaps, find it more demanding to work at this pace. It has been suggested that more accidents at work places occur during certain periods of the working day and during these periods the performance times are approximately the shortest. By and large experimental investigations have been conducted in the laboratories so far. The recent technological developments in the field of telemetry have made it possible to monitor heart rate, breathing rate and G.S.R. of the workers while working without causing any discomfort to them. To have a better understanding regarding the variations in performance times and the 'strain' the slow and fast paced workers are subjected to, an extensive field study has been undertaken. Performance time, heart rate and G.S.R. of workers while performing under actual conditions and throughout the working day, are being recorded using sophisticated data acquisition equipment which includes a Hewlett Packard Computer 21 0A. In this paper, it is proposed to report some of the findings of this study.

- 969 Raouf, A., & Sethi, J. L. Pulse rate difference as a function of information reduction in a combined manual and decision task. Proceedings of the 6th Congress of the International Ergonomics Association, 1976, 552-556.

The effects of information reduction, i.e., information in stimuli, N_{si} \geq information in responses, N_{rj} is investigated. Nine subjects were tested for this study. Each subject performed combined manual and decision task using two distinct "reaches" (R_k) under three levels of N_{si} and five levels of N_{rj} . Pulse Rate Difference (PRD), i.e., pulse rate while performing the task less pulse rate at rest were used as a response variable. The investigations have revealed that N_{si} , N_{rj} and R_k are significant variables and also that for a given R_k , PRD increases as $(N_{si} - N_{rj})$ decreases.

- 970 Raskin, D. C. Attention and arousal. In W. Prokasy & D. C. Raskin (Eds.), Electrodermal activity in psychological research. New York: Academic Press, 1973.

The general aim of this chapter is to discuss the use of measures of electrodermal activity (EDA) in relation to the theoretical concepts of attention and arousal. The presentation consists of three major sections. First, there is a brief history of the use of measures of EDA as indicators of attention and arousal, followed by a more detailed description of the major contemporary theories of those processes. The second section deals with a more detailed analysis of the relationships between various measures of EDA and the theoretical concepts described in the first section. The remainder of the chapter is devoted to a variety of research problems in which measures of EDA have been employed to investigate many of the propositions and concepts developed in the various theoretical approaches to attention and arousal.

- 971 Rasmussen, C. T. Evoked potential correlates of accuracy and confidence in a visual detection task (Doctoral dissertation, University of Arizona, 1972). Dissertation Abstracts International, 1972, 33, 2842B. (University Microfilms No. 72-31, 847)

This study was an examination of the parameters of the visual evoked response to a threshold level stimulus using a signal detection theory paradigm. Use of the signal detection approach allows exploration of possible relationships between confidence of stimulus detection and the averaged evoked response.

Subjects viewed a dim one degree visual target presented to the fovea; the actual stimulus was a threshold level increase in the target intensity. This intensity change was present on only half of the trials, with signal and no-signal trials randomly mixed.

After each trial the subject responded on a five point scale as to his confidence that a signal had been presented. EEG recordings were made from monopolar electrodes located at the occiput, with the reference electrode located at the left ear. These recordings were used to form computer-produced averaged evoked potential for each response condition.

Two long latency, low frequency components, with peak latencies at about 225 and 450 msec, appear to be strongly related to detection and confidence level. This is in spite of the fact that stimulus intensities were identical across all five response categories.

These results are in agreement with those reported by other authors using a two choice ("Yes" or "No") auditory task. The present method, however, allows an examination of the relationship between confidence of detection and the evoked response.

- 972 Ray, J. T., Martin, O. E., Jr., & Alluisi, E. A. Human performance as a function of the work-rest cycle. (Publication 882). Washington, D. C.: National Academy of Sciences -- National Research Council, 1961.

The findings reported in the studies reviewed (a publication span from 1894 to 1960) are in general agreement that both man's performance and his physiological processes exhibit variations that are a function of his being adapted to a 24-hour day. His physiological rhythms will show some, but not complete, adaptation to a non-24-hour cycle when he follows an atypical schedule of activities. However, persons differ widely in their ability to adapt, as well as in the rapidity with which a maximum adaptation may be completed.

Within broad limits, performance does not appear to vary significantly as a function of the work-rest cycle, provided the work-rest and sleep-wakefulness ratios are held constant and the period of observation does not exceed one week. An exception is the decrement commonly observed in the performance of certain watchkeeping or vigilance tasks. Man is apparently capable of maintaining high-level performances on various tasks while living according to rather rigorous, atypical work-rest schedules, at least for short intervals of time. It may be postulated, however, that in many experiments various adaptive and motivational factors might be preventing the occurrence of differences in performance, especially under the conditions of short-term study. These factors are of decided importance and may account for some of the conflicting results obtained in the laboratory, field, and industrial studies reviewed.

Since some individuals continue to make adjustments to a new work-rest cycle over a period of several months' duration, the need for additional investigations of the processes involved in these long-term adjustments is evident. Until such investigations have been completed, and more definitive information is obtained, accurate descriptions of the apparently complex relations among physiological and performance variables, work-rest cycles, sleep-wakefulness cycles, and the durations and activities of the work, rest, and sleep periods will not be possible.

- 973 Rebert, C. S. The effect of reaction time feedback on reaction time and contingent negative variation. Psychophysiology, 1972, 9, 334-339.

The contingent negative variation (CNV) and simple reaction time (RT) of human Ss were recorded when the imperative stimulus (IS) was either single flash, repetitive flash, numeric feedback of RT, or numeric no-feedback of RT. Reaction times were not significantly shorter, but CNVs were larger when IS was flicker rather than single flash. RT was slightly faster, but CNV was no larger in one study when explicit numeric feedback was provided than when it was not. Slightly larger CNVs were obtained in the no-feedback condition in a third experiment. Conclusions were: (1) that the effectiveness of flicker vs flash in producing a CNV difference was due to S's attempts to obtain feedback in the flicker condition and not to feedback per se, and (2) that the general hedonic quality of the experiment produced by the degree of positive or negative reinforcement is a potent feedback variable, whereas RT feedback per se is not.

- 974** Rebert, C. S. Further analysis of CNV and reaction time. Electroencephalography and Clinical Neurophysiology, 1974, 37, 435-436. (Abstract)

It can be concluded that there is a tendency for individuals with faster responses to have larger CNVs. Within most subjects there is no relationship between CNV and RT, except that the slowest RTs are associated with small CNVs. The slowest RT trials may reflect qualitatively different responses than other trials and might be profitably excluded from CNV averages under some conditions.

The results support the conclusion that CNVs and RTs reflect relatively independent biological functions, and they indicate why CNVs are often found to differ at RT extremes, yet are not highly correlated with RT.

- 975** Rebert, C. S. Functional cerebral asymmetry and performance: I. Reaction time to words and dot patterns as a function of EEG alpha asymmetry. (Submitted for publication to Behavioral Neuropsychiatry.)

Alpha activity in left and right hemispheres was recorded while subjects performed in verbal and nonverbal target detection/reaction time tasks. Alpha in the right hemisphere was paradoxically enhanced during the nonverbal task, but RT varied as a function of differential hemispheric arousal in the expected manner-e.g., RT to words was fastest in the performance set showing greatest relative left hemisphere arousal.

- 976** Rebert, C. S. Functional cerebral asymmetry and performance: II. Individual differences in reaction time to word and pattern stimuli triggered by asymmetric alpha bursts. (Submitted for publication to Behavioral Neuropsychiatry.)

The difference in mean square values of EEG alpha in left and right hemispheres recorded from parietal scalp regions of 5 female and 6 male human Ss was used to trigger 50 msec presentations of words or random dot patterns, and reaction times to correctly detected target stimuli were obtained. In 9 of 11 Ss the effect of left and right triggering was opposite for word and pattern stimuli, although in only 4 Ss were results consistent with a simple interpretation of alpha as an "idling" rhythm. The results support the hypothesis of complementary hemispheric specialization and indicate that overt performance depends on the state of functional cerebral asymmetry.

- 977** Rebert, C. S., & Knott, J. R. The vertex non-specific evoked potential and latency of contingent negative variation. Electroencephalography and Clinical Neurophysiology, 1970, 28, 561-565.

Potentials evoked at the vertex of ten human subjects by clicks or light flashes were compared to potentials elicited during conditions that gave rise to contingent negative variations (CNVs). It was tentatively concluded that CNV onset does not occur before 400 msec after a warning stimulus, and that CNV onset or amplitude or both are related to the optimal conditioned stimulus-unconditioned stimulus interval in classical conditioning. The data were also interpreted as suggesting independent genesis of initial and late components of the vertex evoked potential-CNV complex. Some methodological problems associated with the analysis of CNV experiments were also suggested by the investigation.

- 978** Rebert, C. S., & Low, D. W. Differential hemispheric activation during complex visuomotor performance: PONG. Unpublished manuscript, Stanford Research Institute.

Bilateral EEGs were recorded from central, temporal and parietal scalp locations from 7 male and 7 female human Ss while they were engaged in verbal and nonverbal tasks. Alpha power was higher in the right hemisphere when Ss listened to verbal material being read to them; the reverse was true when Ss performed in an imaginative block rotation task. Compared to intergame rest periods, alpha power was suppressed in the right hemisphere when Ss either watched or played PONG (T.V. tennis). In temporal and parietal areas alpha asymmetry increased linearly during most of a rally, but the trend was reversed during the 1 sec preceding an error. The central leads showed an opposite trend during rallies and exhibited no reversal prior to an error. The fact that watching PONG was nearly as effective in producing alpha asymmetry as playing the game implies that the asymmetry was due most to perceptual factors. This interpretation is consistent with the finding of greatest asymmetry parietally and lack of change in central leads preceding errors.

- 979** Rebert, C. S., McAdam, D. W., Knott, J. R., & Irwin, D. A. Slow potential change in human brain related to level of motivation. Journal of Comparative and Physiological Psychology, 1967, 63, 20-23.

Negative slow potential change (contingent negative variation or CNV) in human cortex which develops in the foreperiod of a reaction-time experiment was studied as a function of motivational variables. When the warning signal indicated that a difficult-to-detect auditory stimulus would follow, CNV was greater than when an easily detected stimulus was signaled. Instructing Ss to press a key at the onset of the second stimulus resulted in development of larger anticipatory CNV than when no response was instructed. When muscular effort required to complete a response to the 2nd stimulus was varied, larger CNV accompanied greater effort. These findings extend those of other investigators and support the conclusion that CNV reflects cerebral mechanisms related to motivation.

- 980** Rebert, C. S., & Sperry, K. G. Subjective and response-related determinants of CNV amplitude. Psychophysiology, 1973, 10, 139-144.

The effect on contingent negative variation (CNV) of varying the difficulty of obtaining reaction time (RT) feedback and the relationship of CNV and RT were studied. Subjects (Ss) were run in a reaction-time-foreperiod experiment with 4 conditions of varying RT feedback duration. Subjective reactions to the experiment were recorded by Ss on a questionnaire and were divided by the experimenters into two highly significant sets of mean CNVs based on the most "positive" and most "negative" responses to the conditions. CNVs and their associated RTs were analyzed, and a significant rank order correlation over all Ss showed there was a trend for individuals with faster RTs to have larger CNVs. Individual correlations were low and highly variable. Only the very slowest RTs were associated with small CNVs. The failure of explicit RT feedback to have any effect upon CNV amplitude is in agreement with previous studies, and the significant association of CNV amplitude with written reactions of Ss might prove a useful tool for further CNV analysis. The RT data indicated that CNVs and RTs reflect relatively independent functions and that very slow RTs may reflect qualitative changes in S's psychological state which affect both RT and CNV; and such trials might appropriately be eliminated from CNV data analysis.

- 981 Rebert, C. S., & Tecce, J. J. A summary of CNV and reaction time. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 172-178.

A survey of the literature concerning the relationships between CNV and reaction time led to the conclusion that those two events are, for the most part, independent and reflect the activity of different psychological processes.

- 982 Reeves, C. T. Use of Kirlian photography in fatigue assessment (USAMC-ITC-02-06-76-403). Red River Army Depot, TX: Safety Engineering Department and Texas A&M University, December 1975. (NTIS No. ADA 026349)

In this research, assessment of fatigue by using Kirlian photography was investigated. Both mental and physical fatigue were included in the study. The mental stressor used was engineering graduate school class lectures; the physical stressor was softball games played under hot, humid atmospheric conditions. The photograph parameter used to indicate fatigue was the fingertip's corona diameter. A Wilcoxon signed rank test at the 0.99 level of significance determined statistically significant corona diameter changes did occur in both cases. The diameter significantly increased after applying the physical stressor and decreased after applying the mental stressor.

- 983 Regan, D. Evoked potentials and sensation. Perception and Psychophysics, 1968, 4, 347-350.

Objective physiological measurements (evoked potentials) were compared with the corresponding psychophysical observations for human Ss. Discrepancies were found between the amplitude of the steady-state evoked potential (EP) and the sensations of flicker produced by visual stimuli of different modulation depths. Poor correlations were also found between subjective De Lange curves and amplitude vs frequency curves for the EP under conditions of chromatic adaptation. It is suggested that two classes of EP can be distinguished; one correlates well and the other correlates poorly with sensation.

- 984 Regan, D. Evoked potential and psychophysical correlates of changes in stimulus colour and intensity. Vision Research, 1970, 10, 163-178.

The intensities of two superposed beams of different colours were sinusoidally modulated at frequencies near 16 c/sec so as to generate an alternating-wavelength stimulus, and used in a joint psychophysical and evoked potential (EP) investigation. The relative phases and modulation depths of the two beams were varied and the conditions for minimum EP amplitude compared with the conditions for minimum (or zero) subjective flicker. When the relative modulation depths of the beams were varied, the fundamental EP gave (a) no minimum, or (b) a minimum displaced from the subjective minimum, or (c) rarely, a minimum coincident with the subjective minimum. This depended on the subject and the electrode position. Cases (a) and (b) could be explained by the findings that (1) the relative phases of the beams for minimum subjective flicker differed considerably (50 - 110) from the relative phases for minimum EP, and (2) the relation between the amplitude of the fundamental component of the EP and stimulus modulation depth was different for different colours.

Minimum subjective flicker seems to be related to stimulus intensity, and modulation depth in a different way than is minimum amplitude of the fundamental component of the EP, so that whether the subject sees flicker has no correlation with the minimum in the fundamental EP.

986 Regan, D. Evoked potentials in psychology, sensory physiology and clinical medicine. London: Chapman & Hall, 1972.

The following subjects are reviewed in this book:

1. The activities of single neurons and evoked potentials.
2. Sensory information processing and evoked potentials.
3. Evoked potentials and psychological variables [habituation, attention, distraction and vigilance are discussed in this chapter].
4. Clinical applications of evoked potentials.
5. Techniques in evoked potential research.

Nine hundred and fifty-three references are cited in the bibliography.

986 Regan, D., & Beverley, K. I. Relation between the magnitude of flicker sensation and evoked potential amplitude in man. Perception, 1973, 2, 65.

...ates of the subjective magnitudes of flicker sensations correlate poorly with the amplitudes of electrical brain responses (evoked potentials). A power function of exponent between 0.9 and 1.5 describes the relation between stimulus and subjective sensory magnitude. On the other hand, the relation between stimulus and objective measure varies with electrode position, is different for different frequency components of the evoked potential, and may not be a power function at all.

As a rough generalization, correlations between evoked potentials and perception are poorer when spatially-unpatterned stimuli are used than when the stimulus is spatially patterned.

987 Regan, D., & Richards, W. Independence of evoked potentials and apparent size. Vision Research, 1971, 11, 679-684.

When the eyes converge, there is a large reduction in the apparent size of an invariant retinal image. If the magnitude of the EP is correlated with apparent, rather than retinal image size, then convergence should also lead to a change in the relation between EP amplitude and the check size of an oscillating checkerboard stimulus. No definitive change in the EP measure was found, suggesting that the neural constraints upon the EP are more peripheral than the site of size scaling.

- 900 Regan, D., & Spekreijse, H. Electrophysiological correlate of binocular depth perception in man. Nature, 1970, 225, 92-94.

We conclude, therefore, that the difference between the responses to horizontal and vertical changes in retinal disparity in conditions of fused binocular viewing is a correlate of stereoscopic depth perception and is not the result of displacements of the retinal image. This correlation is of interest for the following reason. Poor correlations have been reported between perception and EPs to repetitive stimuli which lack spatial structure. One reason for this finding might be that such EPs are strongly influenced by neural activities which take place at an early stage in visual processing. This possibility suggested the design of an experiment in which the EP should largely reflect centrally determined activity. In this experiment it was intended that there should be minimal stimulation of either eye alone, so that peripheral processes would probably be unimportant. The stereoscopic correlate described above presumably reflects neural events which are determined at a late stage in the processing of visual information, and so might be more closely related to psychophysical quantities than previously measured features of EPs.

- 900 Reinberg, A., Vieux, N., Laporte, A., Ghata, J., & Migraine, C. Rapid adjustment of circadian rhythms in shift worker of an oil refinery. Proceedings of the 6th Congress of the International Ergonomics Association, 1976, 507-509.

Some subjects (selected shift-workers) are able to rapidly adjust (within 1 or 2 days) the timing of their physiological circadian rhythms to changes of work-rest schedule in the 24 h scale. In shift workers, able to adjust quickly, the rapid rotation of shifts (3-4 days) seems to be well tolerated from a chronophysiological point of view. This fact has to be kept in mind since, socially as well as psychologically the rapid rotation is preferred to the conventional weekly shift.

- 900 Reinond, A., & Lesevre, N. Variations in average visual evoked potential as a function of the alpha rhythm phase ("autostimulation"). Electroencephalography and Clinical Neurophysiology, 1967, Supplement 26, 42-52.

The authors have studied, in normal man, the variations of the average visual evoked potential (VEP) as a function of the phase of the alpha rhythm at the time of arrival of the stimulating flashes.

Four different phases of the alpha rhythm, at regular intervals in the cycle, were tested: the time of the maxima of a source and of a sink of the alpha rhythm, and of crossing the baseline before a source and before a sink.

The greatest differences are seen with responses obtained by triggering the flashes at maxima (source and sink); mainly the rhythmic after-discharge is affected: (1) this after-discharge is inhibited when flashes are given at the time of a maximum of an alpha source and consequently, allowing for a perceptive integration time of about 50 msec, perceived by the subject at the time of the maximum of an alpha sink; (2) this rhythmic activity appears greatly increased when the flashes, triggered on the maximum of an alpha sink, are seen by the subject about 50 msec later, at the time of the maximum of a source, to such an extent that in certain cases it may appear prematurely and mask the whole VEP; (3) compared with the "average alpha rhythm" obtained in the absence of any sensory stimulation, this rhythmic activity (early or late) has the same topography and the same frequency but is of considerably greater amplitude.

These results suggest that the phase of the alpha rhythm affects the response indirectly by means of a non-specific mechanism of synchronization or recruitment whose release (which may correspond to a phase of lowered alertness and thus of hypoexcitability) or inhibition (increased alertness) transforms the appearance of the VEP.

- 991 Requin, J. Some data on neurophysiological processes involved in the preparatory motor activity to reaction time performance. Acta Psychologica, 1969, 30, 358-367.

This study is concerned with an analysis of monosynaptic reflexes during the foreperiod in a simple reaction time situation. There is a dissociation in direction, time course and correlation with motor efficiency of the changes of excitability of the spinal structures controlling the muscles involved and not involved in the motor response respectively: the inhibition of reflexes observed in the involved muscle is more predictive for the performance level and more sensitive to the effect of probability of occurrence of the signal to respond to than the augmentation of reflexes observed in the non-involved muscle. The significance and the neurophysiological mechanism of this inhibition are discussed.

- 992 Rey, P. The interpretation of changes in critical fusion frequency. In W. T. Singleton, J. Fox & D. Whitfield (Eds.), Measurement of man at work. London: Taylor & Francis, 1971.

Our intention is, in this paper, to discuss in what conditions, in laboratory experiments or in field studies, a decrease in CFF can be postulated to be due to mental fatigue. It is well known that, when the frequency of an intermittent light is increased to a certain value, our eye is no longer able to perceive flicker; the frequency of this light at which fusion just occurs is usually called critical fusion frequency or CFF. Since the time Simonson and Enzer suggested that CFF could be used as an indicator of mental fatigue, numerous studies have been devoted to this problem (Simonson and Enzer 1941, Schmidtke 1965, Grandjean 1967). As pointed out by Schmidtke the usefulness of the decrease in CFF as a test for mental fatigue hinges on the question as to whether the variability of this function has its source in the receptors, or whether it is of central origin (Schmidtke op. cit.). This author showed that, measured in the same conditions, CFF could be lowered even in purely mental tasks, that is tasks which did not involve a visual participation.

However, we have to remember that CFF is primarily a visual performance and that it reflects the activity of the visual system, from receptors to cortex. Therefore, we believe that a more valuable approach to our knowledge than before-and-after-work measurements depends upon a complete investigation of all the factors which may influence CFF apart from fatigue, in order to avoid attributing to it what is due to other variables. Moreover, CFF is not sufficient to describe man's perception of flicker. De Lange has shown that fusion can be experienced, at any frequency of a sinusoidally modulated light, provided that the modulation amplitude is set, for each frequency, at an appropriate level; plotting, on a double log scale, frequency versus modulation amplitude, this author described an entire curve which is called after his name. The point at which the curve cuts the x-axis is the well-known CFF; everything located under the curve is perceived as flickering, everything above it is perceived as fused (de Lange 1957).

Investigations of the de Lange curve proved to be very fruitful in emphasizing the close connections which exist between flicker and the activity of the visual system.

In this paper, we will refer to recent researches which deal either with CFF alone or with the entire de Lange curve; we will consider different parameters which may play a role in depressing flicker fusion thresholds without mental fatigue being involved in these experiments.

- 902 Riemersma, J. B. J., Sanders, A. F., Wildervanck, C., & Gaillard, A. W. Performance decrement during prolonged night driving. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

It is argued that effects of fatigue on performance should be progressive as time goes on and that, consequently, initial decrements, as found in many vigilance tasks, cannot be ascribed to what is usually called fatigue. Studies on very long-term performance, in particular long-term driving, have generally failed to show progressive effects. This casts some doubt on the usual implicit assumption that fatigue and long-term work are uniquely related. It is probable that effects of declining diurnal rhythm, monotony and accumulating lack of sleep will also contribute to fatigue.

In an attempt to demonstrate progressive decrement, an exploratory experiment was carried out where the effects of long-term work, declining diurnal rhythm and accumulating sleep loss converge. Subjects carried out a continuous driving task between 22.00 h and 6.00 h, which was preceded and followed by two driving tests of 45 minutes each. In another condition they had only the pre- and post test and slept in between.

The results showed progressive decrements of performance on several performance measures, including lane drifting and two subsidiary tasks. In general, considerable recovery was observed in the post-test. Although heart rate declined and heart rate variability increased during the long nightly spell, strong arguments are raised against relating heart rate and fatigue. Suggestions for future research are discussed.

- 904 Rietveld, W. J., Tordoir, W. E. M., & Hagenouw, J. R. B. Influence of attentiveness, of vigilance task difficulty, and of habituation on cortical evoked responses and on artifacts. Acta Physiologica et Pharmacologica Neerlandica, 1966, 14, 18-37.

Nearly all authors describe an increase in amplitude of cortical evoked responses both to visual and auditory stimulation when the subjects' attention is focused on the stimuli. From the descriptions of the experiments where the visual evoked response was investigated it can be inferred that, in most cases, the recorded responses were contaminated by artifacts. Since the two papers in which no such increase was reported are the only ones where the recorded response could be supposed to be free from artifacts the question naturally arose whether, in those cases, the observed increase might not be due to an increase of artifact amplitude. Two series of experiments where visual and auditory vigilance tasks were given, in one case under conditions when the response was contaminated and in the other where contamination was excluded showed that the auditory channel appeared to behave differently from the visual one in that, while in the case of visual stimulation attention caused a decrease in amplitude both of the uncontaminated response and of the artifacts—so that an artifact increase cannot be invoked in the explanation of the response increase reported by most authors—attention increased the amplitude of the response and of the artifact in the case of auditory stimulation. The visual task was experienced as much more difficult than the auditory task; in the latter performance was much better. The visual task appeared to become somewhat easier with habituation, and performance improved.

In a third group of experiments the visual task was made easier and the auditory task more difficult. Now attentiveness increased response amplitude in the first case and diminished it in the second. This, together with the fact that subcortical responses have been reported to increase in the attentive state, suggests that in the case of a strong stimulation and of a difficult task cortical responsiveness is lowered. Background EEG's show that, under these conditions, there is a strong suppression of the alpha-rhythm; this suppression becomes less marked as the subject gets used to the procedure.

- 986 Rietveld, W. J., Tordoir, W. E. M., & Hagenouw, J. R. B. The influence of alertness on the amplitude of the visual evoked response and on reaction time. Acta Physiologica et Pharmacologica Neerlandica, 1967, 14, 286-299.

In five subjects the way in which the amplitude of the cortical responses to presentation of light flashes, and the corresponding reaction times depend on the length of the interval between a warning click given prior to the test stimulus and the flash itself was studied, together with the incidence of alpha-blocking at the moment the flash was given.

With intervals below 100 ms : RT is longer than in the non-alerted state; in the 0-500 msec range it decreases with increase of click-flash interval; it slowly increases again as the interval is further increased. The amplitude of the cortical evoked response shows a sharp increase with increase of interval from zero to about 200 msec, to diminish again upon further lengthening of the interval. Response latencies are not systematically dependent on interval duration. Alpha-blocking does not occur at interval lengths below 100 msec; from 100 msec up its occurrence increases with increase of interval duration until, at an interval of one second, it is present in 90% of the trials.

- 987 Ritter, W., & Vaughan, H. G., Jr. Averaged evoked responses in vigilance and discrimination: A reassessment. Science, 1969, 164, 326-328.

With the use of monopolar recordings for averaged evoked responses, detected signals in a vigilance task are associated with a late positive component which is absent for undetected signals as well as nonsignals. Bipolar recordings obscure the late positive component associated with detected signals. The data suggest that the late positive component represents cerebral processes associated with evaluation of unpredictable changes in stimulation.

- 988 Ritter, W., Vaughan, H. G., Jr., & Costa, L. D. Orienting and habituation to auditory stimuli: A study of short term changes in average evoked responses. Electroencephalography and Clinical Neurophysiology, 1968, 25, 550-556.

Short term habituation in human subjects was studied by a method which provided a stimulus by stimulus analysis of averaged evoked responses. Tones delivered every 2 sec resulted in a rapid drop, during the first few stimuli, in the amplitude of the positive component of vertex responses which peaks between 150 and 200 msec; but no similar change was found for tones delivered every 10 sec. The rapid drop for the faster rate of stimulation was considered to have only the appearance of habituation, and was viewed as reflecting refractoriness within the auditory system. On the other hand, when the first stimulus was presented in an unpredictable manner it elicited a large positive component with a peak latency of about 300 msec. Similar responses were obtained when an unpredictable pitch change was presented in an effort to elicit dishabituation. Predictable pitch changes did not produce these results. The 300 msec component was seen as reflecting a shift of attention associated with the orienting response.

- 888 Robinson, D. N. Visual reaction time and the human alpha rhythm: The effects of stimulus luminance, area, and duration. Journal of Experimental Psychology, 1966, 71, 16-25.

Human Ss in a visual reaction-time experiment responded to stimuli of systematically varied luminance, area, and duration. Reaction time, EEG alpha blocking latency, and alpha blocking duration were recorded and measured. The major findings were: (a) Over a range of luminances (0.65-10.0 mL) and exposure durations (10-200 msec) constant $I \times t$ products result in constant blocking latencies; i.e., Bloch's law. (b) Constant products of $I \times A$ (Ricco's law) do not lead to constant blocking latencies beyond areas of 1° . (c) Reaction time decreases with increased luminance or area under equal-energy conditions and is independent of duration over the range of t employed. (d) Blocking duration increases with stimulus duration but is unaffected by luminance. (e) Correlations between reaction time and properties of the alpha rhythm are determined, in large part, by stimulus variables.

- 888 Roessler, R. Physiological correlates of optimal performance (NGR 44-003-031). Houston, Texas: Baylor College of Medicine, Department of Psychiatry, July 1971.

Although there is some suggestion in the drop-out and sleep data from this experiment that it was distressing, the weight of the data can only support the interpretation that, if it was stressful at all, it was minimally so. Most important is the absence of any significant decrement in the level of performance throughout the 3 days, the criterion which was adopted as the operational indicator of stress. The mood variables and all of the physiological data apart from sleep are in keeping with the interpretation that the subjects were not highly activated--i.e., were not stressed. It must be concluded therefore that only the sleep data and the possible relationship of personality to dropping out are of potential relevance to the problem of predicting human vigilance performance in space flight. The data suggests that well-trained men can continue to perform well for extended periods (of at least 3 days) if the schedule is one permitting time for sleep and the tasks themselves are ones which can be performed with few, if any, errors. This interpretation, for the most part, fits with actual space flight experience.

On the other hand, the Phase I sleep deprivation results suggest the likelihood that more prolonged sleep deprivation would be associated with performance decrement. Since such situations have occurred in space flight previously and likely will again, this possibility is being pursued presently in a new experiment in which subjects will be kept awake and performing almost continuously for forty-eight hours.

- 1000 Roessler, R. Personality, psychophysiology, and performance. Psychophysiology, 1973, 10, 315-327.

Research relating personality variables to physiological responsivity and to motor performance is reviewed. Trait anxiety is not related to physiology but ego strength is related to change in physiological levels. Skin conductance is most consistently related to ego strength across experimental conditions and across subjects. Other physiological variables are also related to ego strength in certain subjects under certain conditions. Data relating ego strength to other personality variables and to psychomotor performance is also reviewed. A theory relating personality to physiological change is proposed.

1001 Roessler, R., Collins, F., & Burch, N. R. Heart rate response to sound and light. Psychophysiology, 1969, 5, 359-369.

The heart rate (HR) response to five intensities of sound was examined in 18 subjects and to five intensities of light in 12 subjects. Each subject was tested on four occasions at monthly intervals. After covariance adjustment, significant acceleration to sound was found within the first 5 beats after stimulus onset but no significant deceleration occurred. There were no differences between testings. Individuals' HR acceleration was reliable over testings and differing experimental contexts. No habituation occurred and no consistent relationship between HR response and ego strength was found. There was no significant HR response to light stimulation. The results were discussed in relation to Graham and Clifton's (1966) hypotheses concerning the relationship of the HR response to the orienting reflex (OR).

1002 Rohmert, W. An international symposium on objective assessment of work load in air traffic control tasks. Ergonomics, 1971, 14, 545-547.

The first International Symposium on Objective Assessment of Work Load in Air Traffic Control Tasks, arranged by the 'Stress in Air Traffic Control Research Association - SATCRA' in June 1971 at Darmstadt, is introduced. A distinction is made between objective methods and results of the determination of stress of work tasks and subjective strain on the controllers due to these stressing factors. Certain stressors cause different strain in different controllers because of their different individual capacities and abilities. Methods and equipment for determining individual capacities and approaches for correlating stress and strain are referred to.

1003 Rohmert, W. Determination of stress and strain of air traffic control officers. In K. E. Klein (Ed.), Methods to assess workload. AGARD Conference Preprint, No. 216, 1977. (Available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.)

Heart-rate is an integrating measure of strain. Heart-rate is not only influenced by the mental load of the controller, which may be evaluated by determining the number of aircrafts under control or the rated difficulty in fulfilling the task, heart-rate is also influenced by the more emotional stress which can be evaluated by the number of aircrafts which will be expected. The number of expected aircrafts is reaching its maximum before the number of aircrafts under control or the rated difficulty is showing maximal values. Due to these emotional reactions an increase in the intentional basic tension of the air-traffic controller can be expected. Due to this hypothesis heart-rate must show an increase also with the increasing number of aircrafts expected. The highest values of heart-rate occur not only at the peak of mental load but also at the peak of emotional load.

By some further additional experiments it could be shown that a good prediction of the strain measure heart-rate could be gained also by evaluating the stress measure of number of aircrafts under control only. And as far as heart-rate is influenced moreover not only by mental but also by emotional work load, we preferred this measure for evaluating strain. This does not exclude that other strain measures allow a suitable description of specific components of the work load of air-traffic controllers. This might be shown in some examples of measurements of tremor activity as well as catecholamine secretion.

- 1004 Rohmert, W., & Laurig, W. Zusammenhang zwischen belastungs- und beanspruchungsparametern bei fluglotsen in der flugverkehrskontrolle. [Relationship between stress and strain parameters in flight controllers in air traffic control.] Arbeitsmedizin-Sozialmedizin-Arbeitshygiene, 1972, 7, 252-257.

Results of field studies with 34 subjects in air-traffic-control show significant correlations between heart rate as a parameter of strain and the number of planes controlled by the subject. Furthermore a strong correlation between heart rate and subjective sensation of difficulty of the situation was demonstrated. The methods demonstrated and discussed render possible a prediction of variations of the parameters of strain by analyses of suitable parameters of stress. There is an indication to believe that the correlation between heart rate and sensation of difficulty proves the assumption, that parameters of strain reflect components of the complex strain of the subject.

- 1005 Rohmert, W., Laurig, W., Philipp, U., & Luczak, H. Heart rate variability and work-load measurement. Ergonomics, 1973, 16, 33-44.

Heart rate variability is a result of the superimposition of different sources of variation which are systemized. Three parameters are used to describe the phenomenon of heart rate variation. The range of variation of these parameters is discussed using examples from both laboratory and field investigations. Analyses demonstrate a correlation between heart rate and their variability. Discussion of the variation of the chosen parameters suggests that, when heart rate variability is used as a measure of strain in field research, strain might be under-assessed.

- 1006 Rohrbaugh, J. W., Donchin, E., & Eriksen, C. W. Decision making and the P300 component of the cortical evoked response. Perception and Psychophysics, 1974, 15, 368-374.

The amplitude of P300, and of other components of the evoked potential, was examined during a task which required Ss to make a response appropriate to the conjoint properties of two rapidly successive visual patterns. In one set of conditions, the task was structured such that both stimuli were needed for the choice judgment. In another set of conditions, the task was changed from choice to simple RT by presenting the patterns in a predictable order. It was observed that P300 was enhanced during the choice RT conditions and that this enhancement was present only for the P300 following the stimulus permitting the choice and not the other, relevant but not decisive, stimulus appearing in close temporal proximity. An appreciable degree of independence between P300 and other components was indicated by the appearance of P300 under conditions in which other evoked potential components were entirely refractory. The data support an account for P300 in terms of poststimulus processes, such as decision making, and not in terms of preparatory adjustments.

- 1007 Rohrbaugh, J. W., Syndulko, K., & Lindsley, D. B. Brain wave components of the contingent negative variation in humans. Science, 1976, 191, 1055-1057.

In a contingent negative variation* paradigm with two stimuli paired at an interstimulus interval of 4 seconds, two distinct waveforms having functional and topographic differences are observed. An early wave is maximal over the frontal cortex and is elicited by the warning stimulus. A later wave, maximal over the motor cortex, precedes the imperative stimulus and is identified with preparation for motor response.

- 1008 Rohrbaugh, J. W., Syndulko, K., & Lindsley, D. B. Frontal negative waves following unpaired tones: Their relation to task variables. Psychophysiology, 1977, 14, 92. (Abstract)

When the CNV interval is lengthened to 4 sec or more, separate early and late waves often can be observed. In a previous report (Rohrbaugh et al., Science, 1976) it was suggested that the early negative wave following a warning stimulus is related more to characteristics of that stimulus than to the contingency between warning and imperative stimuli. In the experiment described here we have recorded negative waves following single (unpaired) tone pips, and we have related the amplitude of these waves to a variety of task variables. In all cases the waves are distributed maximally over frontal sites, where they can attain amplitudes of 15 μ V or more within the first sec and can persist for up to 2 sec. Compared to no-task conditions, instructions simply to count stimuli produced a several-fold increase in amplitude. Further enhancement was obtained by requiring a difficult pitch discrimination, or by embedding the counted stimuli in a train of more frequent non-targets. Separate conditions using simultaneous trains of visual and auditory stimuli (each train having both rare and frequent stimuli) established that the enhancement occurred only for stimuli in the designated target modality. While most of these tasks elicited also a large parietal P300, it appears that P300 and the negative afterwave can be dissociated. P300 was nearly absent during the simple counting condition (which yielded a large negative wave) and, conversely, the infrequent omission of a tone pip from a regular train yielded clear P300s but no discernible negative afterwave.

The ubiquity of these negative afterwaves suggests that they often may be present in various CNV paradigms as well, where they could account for an appreciable portion of the CNV waveform.

- 1009 Rosadini, G., & Rossi, G. F. Spectral power analysis of the electroencephalogram during physiological sleep in man. Activitas Nervosa Superior, 1969, 11, 106-110.

Preliminary results of a spectral analysis of cerebral electrical activity during waking and nocturnal sleep of healthy subjects are reported. The occurrence and characteristics of rhythmicity were considered. Rhythmicity (i.e. periodic oscillating potentials, phase-locked in time) is present during relaxed wakefulness and during sleep. However, frequency and topographical distribution of rhythms is different in the two conditions. Furthermore, rhythmicity is quite evident in certain sleep phases and not in others. The different quantity, frequency and spatial distribution of electrical rhythms observed in wakefulness and in the several sleep phases indicate that these functional states may be mediated by different brain systems or mechanisms.

- 1010 Rosen, S., & Czech, D. The use of electro-oculography for identifying phases of cognitive process. Psychophysiology, 1966, 3, 203-212.

The present investigators were partly concerned with possible uses of electro-oculography for studying the cognitive process in decision-making situations involving nonneutral visual stimuli.

S was faced with receiving an electric shock if on critical trials he correctly reported (manually) the identity of the visual stimulus, or with escaping shock by incorrect reporting. Electro-oculogram responses were ascertained to identify eye movements. The first study employed slit geometric figures as critical stimuli and nonslit figures as noncritical stimuli. The second study differed only in using blanks as critical and nonblanks (figures) as noncritical stimuli.

The 80 males in the first study showed longer ocular latency, then greater ocular avoidance (narrower excursions) but longer stimulus viewing, then longer post-stimulus viewing on critical compared to noncritical trials. The 25 males in the second study showed relatively greater ocular latency, then greater ocular avoidance and briefer stimulus viewing, then briefer poststimulus viewing on critical trials. Discrepancies between the two studies were discussed.

The results clearly indicate the applicability of electrooculography for identifying phases of cognitive process.

- 1011 Rosenbrock, F. Hardware problems in ergonomics measurements. Ergonomics, 1971, 14, 617-623.

The most difficult problem in analysing man-machine systems is the assessment of the operator's work load. The methodological difficulties are evident because of the human complexity and the necessity of avoiding any interference in the work situation. These problems, especially the great number of data needed, necessitate new concepts in ergonomics measurements.

By using an actual problem, the analysis of the task and work load of radar controllers, the application of multichannel automatic data acquisition and processing is demonstrated. For assessing strain, advantage is taken of the physiological variables: electro-cardiogram (ECG), electro-oculogram (EOG) in both directions, electro-myogram (EMG) of a back muscle and respiration. To correlate these variables with factors of stress and strain a coding is described, which renders the evaluation of a multi-dimensional work process study automatically and synchronously with the physiological data.

- 1012 Ross, R. M. Vigilance: Summary and reanalysis, Toronto: University of Toronto, Department of Industrial Engineering, September, 1967. [abstracted in AIIE Transactions.]

The purpose of this research was to summarize the literature in the field of vigilance and point out the areas of agreement and disagreement. The first three chapters lay the groundwork in this regard. In addition, several suggestions for future research are made. A model based on a combination of the arousal, expectancy and filter concepts in conjunction with statistical decision theory is developed and used to analyze some of the more important experiments. Further, several practical applications of vigilance research are suggested.

- 1013 Ross, S., Dardano, J., & Hackman, R. Conductance levels during vigilance task performance. Journal of Applied Psychology, 1959, 45, 65-69.

Conductance during a vigilance task and its relationship to performance was investigated. Apparatus and procedure were similar to that used by Mackworth in his "clock" test. Six men and three women students were used as Ss.

The conductance trends over the two-hour session formed three clusters: ascending in four Ss, descending in three Ss, and cyclical in two Ss. No significant differences were found between the performances of these three clusters nor between high and low conductance groups. The results suggest, however, that higher conductance level is associated with better performance.

Eleven of the 15 errors of commission occurred during the first half-hour. None of these were made by the Ss with the four higher conductance levels.

- 1014 Roth, B. The clinical and theoretical importance of EEG rhythms corresponding to states of lowered vigilance. Electroencephalography and Clinical Neurophysiology, 1961, 13, 395-399.

1. States of lowered vigilance are characterized by EEG rhythms corresponding to the period of transition from awakeness to sleeping. Their appearance in the EEG may, however, be infraclinical.

2. The author distinguishes four stages of reduced vigilance and describes their morphological appearance, dynamics, reactivity to external stimulation and responses to methods of activation.

3. Signs of lowered vigilance are most common in narcolepsy and hypersomnia, in organic diseases of the mesodiencephalic region especially those of traumatic, inflammatory and neoplastic origin, in psychomotor epilepsy and in neurotic conditions of all kinds as well as in "vegetative dystonia" including constitutional spasmophilia.

4. The states of lowered vigilance show a marked resemblance to Pavlov's hypnotic phases.

5. It is suggested that signs of lowered vigilance are due to insufficiency of the subcortical mechanisms of activation; these are of particular importance in causing neurotic symptoms.

1016 Roth, W. T. Auditory evoked responses to unpredictable stimuli. Psychophysiology, 1973, 10, 125-138.

The auditory evoked response (AER) to unpredictable stimuli was studied in 18 Ss. One hundred msec sound bursts consisting of either a pure tone or white noise were presented every sec. One type of stimulus constituted the frequent expected stimulus and the other the infrequent stimulus that occurred as a random substitution. For the low probability (LP) stimulus condition, the mean ratio of infrequent to frequent was 1:30; for the intermediate probability (IP), 1:15; and for the high probability (HP), 1:7.5. Ss were instructed to ignore the sounds.

The amplitude of a late positive wave (P3) of the AER was largest in the LP and smallest in the HP condition. There was a general decrease of all AER components over the course of a session. No evidence of dishabituation in the AER to the stimuli following the infrequent stimuli was obtained. The results of a detailed analysis of two orbital leads make it unlikely that eye movement or eye blink could account for the results.

1016 Roth, W. T., Ford, J. M., & Kopell, B. S. Event-related potentials and reaction time fluctuation. Psychophysiology, 1977, 14, 100. (Abstract)

Four hundred fifty moderately loud tone pips separated by a constant 1 sec interval were delivered to 12 subjects. The pips were of three pitches given in a random sequence. The 400 and 1600 Hz pips each had a probability of 0.15, and the 800 Hz pips had a probability of 0.7. For each subject, either the 400 or 1600 Hz pips were designated as targets in a reaction time (RT) task. Recording was from Fz, Cz, and Pz referenced to linked ears, and from eye electrodes.

Stimulus-synchronized averages (SSAs) to infrequent tones contained two prominent waves: a P3 and a slow wave (SW). P3 had a mean latency of 340 msec and was positive in all leads with a parietal maximum. An SW followed P3 and was positive in Pz but negative in Cz and Fz. SW and P3 amplitude were larger, and P3 latency was 15 msec shorter, to targets than to non-targets. SSAs were computed for RT quartiles (Q1-Q4) of each subject. Between Q1 and Q4, P3 amplitude decreased while SW amplitude increased, demonstrating behavioral dissociation of the two waves. Between Q1 and Q4, RTs increased from 366 to 540 msec, while P3 latency (in Cz) increased from 328 to 359 msec. Response-synchronized averages computed for each RT quartile showed no response-related deflections that could explain the effects in the SSAs.

These results imply that differences in the speed of stimulus evaluation account for only a small part of RT variance.

- 1017 Roth, W. T., Ford, J. M., Lewis, S. J., & Kopell, B. S. Effects of stimulus probability and task-relevance on event-related potentials. Psychophysiology, 1976, 13, 311-317.

Stimuli were delivered to 12 subjects in a sequence that included regularly occurring standard tone pips, random warning tone pips, and random white noise bursts. Half the noise bursts were preceded by warning tones (high probability), and half were not (low probability). There were four runs, each having one of two noise burst intensities, and each having the warning tone and noise bursts either both task-relevant to a reaction time task or both task-irrelevant. Event-related potentials (ERPs) were obtained by signal averaging in Fz, Cz, Pz, and eye leads.

The P3 to the warning tone was largest in Pz and was not affected by task relevance. CNVs preceded all the high probability noise bursts. These CNVs had an amplitude of 5 μ V even when the bursts were task irrelevant. Low probability noise bursts elicited large P3s in all leads for the task-irrelevant conditions, but only in Pz for the task-relevant conditions. In Cz the amplitudes of N1, P2, and P3 to the high probability, task-relevant noise bursts correlated with the amplitude of the preceding CNV.

- 1018 Roth, W. T., & Kopell, B. S. The auditory evoked response to repeated stimuli during a vigilance task. Psychophysiology, 1969, 6, 301-309.

The auditory evoked response was measured between the vertex and left ear in 9 Ss. In an extension of the idea of the recovery function, series of tones, including sets of 5 tone pips with $\frac{1}{2}$, 1, or 2 sec between them, and 11 sec between sets, were presented, while Ss were instructed to press a button whenever there was a change in tone length. Because of the slow recovery of this response, no subtraction procedure was necessary. There were 6 runs representing 6 experimental conditions for each S.

Habituation within runs was not observed, but there was significant habituation between runs in spite of a constant vigilance level. The evoked responses to the second and subsequent stimuli of each set were much smaller than to the first, depending on the interstimulus interval within sets. Evoked responses to 65 db stimuli were less than to 85 db, but showed proportionally the same changes with successive stimuli.

- 1019 Roth, W. T., & Kopell, B. S. P 300 -- An orienting reaction in the human auditory evoked response. Perceptual and Motor Skills, 1973, 36, 219-225.

The auditory average evoked response (AER) to unpredictable changes in tone-burst frequency was studied in 12 human Ss who were instructed to ignore all tones. In the vertex-ear leads the AERs to frequent tones contained the usual negative-positive complex (N_1 - P_2 - N_2). The AERs to infrequent tones generally were more positive in the 300-msec region as compared to that region of the AERs to frequent tones. This positivity decreased during the session as did the N_1 - P_2 amplitudes. Average N_1 - P_2 amplitudes were not different for the two stimulus conditions.

- 1020 Roth, W. T., Kopell, B. S., & Bertozzi, P. E. The effect of attention on the average evoked response to speech sounds. Electroencephalography and Clinical Neurophysiology, 1970, 29, 38-46.

The average evoked response to pre-recorded sentences and monosyllables was studied in ten subjects. EEG recordings with electrodes at the vertex and left ear were averaged with the use of trigger pulses generated synchronously at the onset of each syllable. Two tasks were presented. In the first, the subjects were asked to listen to or to ignore certain sentences on which they were later tested for recall. In the second, they heard a list of monosyllables from which they were to distinguish nonsense words from meaningful words.

The amplitude of the evoked response to the first syllable of each sentence was approximately 8 μ V, measuring from N_1 to P_2 whereas the evoked response to subsequent syllables was only 1.5 μ V. A crucial factor in the size of the response may be the duration of the silence between stimuli, since the first syllable of each sentence was separated from the end of the previous sentence by a 3.5 sec pause, whereas the rest of the syllables were separated only by the much shorter pauses of continuous speech.

Attention and nonattention conditions produced differences in the wave forms that were shown by a discrimination index based on multiple cross-correlations between wave forms to be significant at the 0.01 level. These differences were idiosyncratic to the individual subject, usually appearing in the N_1 - P_2 region. Sense and nonsense words could not be distinguished by this discrimination index.

- 1021 Rothman, H. H., & Davis, H. The amplitude of slow evoked cortical responses in relation to temporal features of stimulation. Electroencephalography and Clinical Neurophysiology, 1969, 27, 699-700. (Abstract)

A series of experiments were run to determine how slow evoked cortical responses were affected by temporal features of auditory and shock stimulation, in human subjects. The response was recorded extracranially between vertex and right mastoid. Amplitude was measured from the 100 msec negative peak (N_1) to the 200 msec positive peak (P_2).

The findings suggest that the slow evoked response is influenced by the most recent preceding event, and by a summation of events earlier than the most recent, but not by individual events earlier than the most recent.

- 1022 Rousey, C. L., & Reitz, W. E. Respiratory changes at auditory and visual thresholds. Psychophysiology, 1967, 3, 258-261.

Length of respiratory cycles was monitored while Ss were presented with (1) auditory and (2) visual stimuli varying in intensity. The phenomenon of greatest slowing in respiration occurring at the S's auditory threshold was demonstrated. However, no consistent relationship was demonstrated between length of the respiratory cycle and visual threshold.

- 1023 Rousseau, J. C., Bostem, F., & Dongier, M. Studies on CNV: Interest of recording its progressive construction during summation. Electroencephalography and Clinical Neurophysiology, 1968, 24, 95. (Abstract)

Instead of extracting merely the integrated CNV from the computer or from the magnetic tape, each sequence of stimuli is written out through an X-Y plotter. In this way the progressive construction of the CNV is visualized through each of the 10 or 20 sequences.

This method offers at least 3 helpful possibilities: (1) Facilitating detection and elimination of some artefacts (due to eye movements or psychogalvanic reactions). Comparison of the primary EEG record, on the one hand, with the constructed curve of the CNV, on the other, allows localization of the artefact-containing sequences. It is easy then to extract from the magnetic tape a new CNV, excluding these sequences. (2) Correcting DC potentials, if they are disturbing, or, contrariwise, making sure of the constancy of their influence. (3) Following, step by step, the influence of fluctuations of the mental state on the CNV: for instance, distraction (with no difference in reaction time) may be revealed by the fact that a subject's CNV does not build up at all during part of the experiment, because he was day-dreaming at that time.

- 1024 Rowland, V., Gluck, H., & Wasman, M. Review of Event-related slow potentials of the brain: Their relations to behavior by W. C. McCallum & J. R. Knott (Eds.), Psychophysiology, 1974, 11, 608-610.

This volume is a definitive resource for anyone entering the field and a valuable progress report for all psychophysiology. New as well as old investigators in this field would do well to concentrate on the caveats in the discussions and Knott's statements before embarking on a study or continuing to repeat the uncertainties in techniques the discussion sections of this volume identify. These reviewers heartily endorse the pleas for the use of DC recording and speculate that not using it restricts investigators to sampling epochs too brief for many of the psychophysiology processes they want to study.

The work is well-organized and valuably indexed. It covers methods, physiologic mechanisms, ontogenetic aspects, relationships to human and animal behavior, to autonomic functions and to clinical applications.

The CNV is found independent of some variables. For example, reports claim CNV independence from motor response and readiness potential (Donchin, Weinberg), the P300 component of the evoked response (Donald and Goff), the reaction time (Rebert and Tecce, McCallum and Papakostopoulos), oxygen potential (Walter), lateralized stimulation in split brain humans (Hillyard), and presumed lateralized cerebral functions (Marsh and Thompson).

CNV is claimed to interrelate with other variables or processes, some of them contradictory to the claimed independencies sample above. For example, Becker felt that the RP and the CNV were essentially the same phenomenon. CNV interrelationship was reported with sex of the subject (Knott and Peters), stress (ibid), sleep loss (Naltchik), expectant attention (Weinberg, Tecce and Hamilton), distraction (Tecce and Hamilton), reaction time and accuracy (Cohen), bradycardia (the Lacey, Papakostopoulos and McCallum), phase of respiration (Gullickson and Darrow, with contradictory experience presented by several other investigators).

- 1026 Rozhdestvenskaya, I., & Levochkina, M. A. [Functional states when performing monotonous work and the strength of the nervous system.] (In Russian) In V. D. Nebylitsyn (Ed.), Problems of differential psychophysiology: VII. Moscow, USSR: Pedagogika, 1972.

Studied functional changes in the nervous system during the performance of monotonous mental work by 30 Ss in 3 groups differing in strength of the nervous system. During monotonous work, the inhibitory state of monotony appeared in the nervous system. Ss with stronger nervous systems were more prone to the appearance of this state. In this case, the most important aspect of nervous system strength was that which manifested itself in the absence of EEG photo-driving effects. The inhibitory state of monotony manifested itself in the variability of simple motor reaction latencies and in the absence of the increase in brain electrical activity during the work. The state of monotony affected the shape of work curve and the quality of performance of the work. Drowsiness developed in a wave-like manner and preceded the objective signs of monotony. In some Ss a state of excitation accompanied by an increase in EEG theta-activity was observed during the monotonous task. This state was not related to the strength of the nervous system.

- 1026 Ruchkin, D. S., Sutton, S., & Tueting, P. Emitted and evoked P300 potentials and variation in stimulus probability. Psychophysiology, 1975, 12, 591-595.

There have been a number of reports of a cerebral potential occurring at about the time of an expected but absent stimulus when absence provided significant information for the subject. This potential consists primarily of a positive peak occurring with a latency of about 300 msec with respect to the time of stimulus absence and is referred to as an emitted P300 potential. It has been conjectured that the emitted P300 is a manifestation of the same process that underlies the evoked P300. Evidence supporting this hypothesis is provided by demonstrating that both the evoked and emitted P300 potentials are similarly affected by variation in event probability. A paradigm was used in which click presence and absence provided information. The relative probability of click presence and absence was experimentally manipulated. Both evoked and emitted P300 amplitude responded in the same way to event probability, larger for the less frequent event and smaller for the more frequent event.

- 1027 Ruhm, H. B. Lateral specificity of acoustically-evoked EEG responses: I. Non-verbal, non-meaningful stimuli. Journal of Auditory Research, 1971, 11, 1-8.

Three experiments were performed to determine whether a hemispheric signature is exhibited by these electroencephalic responses (N 80-P 130) evoked by clicks. These studies involved differences in responsivity between hemispheres (a) during monaural stimulation, (b) as a function of inter-signal interval, and (c) under two levels of attention, one produced by S's reading standard magazine material, the other by his performing a discrimination task on the stimuli. A fourth experiment dealt with the effect of aural laterality. Results are summarized as follows: (a) A constant inter-hemispheric relationship was found for stimulation to the L ear, responses being approximately 50% larger at the R hemisphere (T4) than the L (T3). Stimulation of the R ear revealed no such consistent result across Ss. (b) At an inter-signal interval of 400 msec the P2 component, recorded at T4, reached at least 80% of maximum magnitude, whereas at T3 this peak recovered to only approximately 50%, regardless of which ear was stimulated. (c) Attention to stimuli had no differential effect across hemispheres on the P2 component. (d) Responses from both temporal areas and the vertex were enhanced when clicks were presented to the L ear as compared to the R.

- 1028 Rusalov, V. M., & Mecacci, L. [Relationship between stability of attention in a cancellation task and alpha-rhythm frequency of background EEG.] (In Russian) Voprosy Psikhologii, 1973, 19, 32-44.

Measured the relationship between alpha-rhythm and attention in a letter-cancellation task in 36 university students. Alpha, beta-1, beta-2, delta, and theta rhythms were recorded from frontal and occipital points, 1 in each hemisphere, and 20 energetic measures obtained. Nine measures of attention calculated according to 2 methods were used. EEG and attention measures were correlated and factor analyzed. The best index of the stability of attention was a summary measure of productivity of attention suggested by I. L. Baskakova. It showed significant positive correlation with alpha frequency in all recording sites but did not correlate with any of the energetic measures of background EEG.

- 1029 Rust, J. Habituation and the orienting response in the auditory cortical evoked potential. Psychophysiology, 1977, 14, 123-126.

Habituation of the auditory cortical evoked potential, the GSR, and heart rate was measured in 100 male subjects. Stimuli were 31 tones of 1 sec duration with an ISI of 33 sec. All stimuli were sinusoidal, at a frequency of 1000 Hz, and at an intensity of 95 dB (re 20 N/CM²). The EEG was measured from bipolar electrode placement to the Cz and T₃ scalp locations. Evoked potentials were averaged over 3 successive blocks of 10 stimuli. The GSR habituation scores were the regression coefficients over trials of the response amplitude in square root conductance. Significant habituation of all evoked potential amplitude components was found. This was a rapid process occurring between the first and the second 10 stimuli. The habituation score for the most significant evoked potential variable (P200) was found to correlate significantly with the GSR and heart rate habituation scores. These results were interpreted as suggesting that the amplitude of the evoked potential was enhanced by the orienting reaction.

- 1030 Rutenfranz, I., Aschoff, J., & Mann, H. Investigations concerning reaction time in relation to duration of sleep and time of day. In A. J. Benson (Ed.), Rest and activity cycles for the maintenance of efficiency of personnel concerned with military flight operations. AGARD Conference Proceedings, No. 74, 1970. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365; Attn: Report Distribution and Storage Unit)

Circadian rhythm of bodily functions. During the initial test period when subjects were on land and did not keep watch, a clear circadian rhythm was demonstrated by all the variables measured. Thus body temperature and pulse frequency had maximum values at 20.00 hr and minima at 04.00 hr. Potassium excretion reached a peak at 16.00 hr with a minimum at 04.00 hr. This pattern of activity was also reflected in the performance of the psychomotor task for the average reaction times were shortest when tested at 16.00 and 20.00 hr and longest at midnight and 04.00 hr.

When aboard the training ship the circadian rhythm exhibited by body temperature, heart rate and potassium excretion was not influenced by watch keeping duties. Only the reaction time measure showed a clear dependence upon the time at which the subject had to keep watch; the longest average reaction times were recorded in subjects who worked the 20.00 - 23.59 and 04.00-08.00 hr watches.

Dependence of reaction time upon duration of sleep. Subjects who had to work the night watches did not all have the same amount of sleep before they came on duty. This was in part attributable to the rotating shift system, and in part to individual patterns of behaviour. The influence of the duration of sleep on reaction times was assessed at midnight and 04.00 hr. At both of these times, the shortest mean reaction time was measured in subjects who had slept for 4 hr

before beginning the watch. If the subject had slept for a shorter period the reaction times were proportionately prolonged, though when tested at the end of the 4 hr duty period the reaction time was shorter than that at the beginning of the watch.

1031 Rutenfranz, J., Aschoff, J., & Mann, H. The effects of a cumulative sleep deficit, duration of preceding sleep period and body-temperature on multiple choice reaction time. In W. P. Colquhoun (Ed.), Aspects of human efficiency: Diurnal rhythm and loss of sleep. London: English Universities Press, 1972.

(1) Body temperature, reaction time, potassium excretion and pulse rate showed clear 24-hour rhythms when measured at 4-hourly intervals over five separate periods, each of about one week's duration.

(2) Restriction of sleep to about 5 hours per day for three months had no significant effect either on the periodicity or on the daily mean level of reaction time.

(3) Reaction time at night is affected by the duration of the preceding period of sleep or wakefulness. The shorter the duration of the sleep period the longer the reaction time. However, reaction time at night is in all cases longer than during the day. Thus the range of oscillation of the diurnal rhythm of reaction time is largely dependent on whether the subject sleeps or not before being tested during night hours.

(4) Both body temperature and reaction time exhibit circadian rhythms which appear to depend on each other only because of their simultaneous control by Zeitgebers. There is no support for the hypothesis that reaction time and body temperature are causally related.

1032 Rutley, K. S., & Mace, D. G. W. Heart rate as a measure in road layout design. Ergonomics, 1972, 15, 165-173.

It is known that stress, both psychological and physical, along with other factors, increases the heart rate. Making the assumption that a poor road junction design gives rise to greater stress than a good design, experiments have been carried out to determine whether driver heart rate changes can be used as a measure of the stress induced by various road junction designs.

Statistically significant differences in average heart rates were obtained for different parts of motorway interchanges, the order being as expected from a subjective estimate of their difficulty. However, a comparison of corresponding parts of different interchanges did not lead to significant differences. It is believed that this was only through lack of a sufficient number of results and that the method would be sensitive enough if more results were obtained.

A second part of the work investigated instantaneous heart rate rises. It was found that considerable care must be taken in interpreting such changes since very often the control movements required at a junction involve sufficient physical effort to produce heart rate changes of the same order as those produced by psychological stress.

- 1033 Ruttkay-Nedecky, I. Attention and autonomic (heart rate) regulations. In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology, London: Butterworths, 1969.

In conclusion, while there is evidence for reflex facilitation of sensory intake during attention arousal, via central and peripheral threshold variations, the later autonomic changes seem to be instrumental in preparing the subject for being ready for action—i.e. for the consequences of the sensory intake. At the same time the sharp causal relationships in our conceptual schemes of the orienting reaction, or attention arousal should be loosened and due space given to a statistical consideration of the probabilities of occurrence of their important components.

- 1034 Ruttkay-Nedecky, I., Ciganek, L., Zikmund, V., & Kellerova, E. (Eds.), Mechanisms of orienting reaction in man. In Transactions of an international colloquium held in Bratislava and Smolenice, under the auspices of the Slovak Academy of Science, 1965, 351-365.

(1) The rhythmic fluctuations of vigilance can be recognized more differentiatedly by means of the described method used for the evaluation of the EEG. (2) Under the given conditions it was possible to make frequent observations of fluctuations in alertness with a periodicity of about 30 sec and of about 10 min. (3) The greatest variability of the EEG pattern appears in the phase of falling asleep. This phase starts long before the loss of consciousness begins. (4) If during sleep body movements take place, this is preceded by a flattening of sleep. The content of perceptions in these periods is, in general, too insignificant to reproduce, after the final awakening, any memory trace of a fully conscious period. (5) There are statistically significant relations between the EEG-Leitformen, the reaction time and the heart rate during wakefulness. (6) Verbal instructions can have the character of signals for the active setting of the vigilance level. The changes can be traced for a long time after the orienting reaction has ceased. (7) The degree of readiness for achievement finds its expression in the sequence of the varying EEG patterns. Polygraphic recordings may provide certain indications regarding changes in the attitude and motivation of the subjects.

S

- 1035 Sakano, N., & Pickenhain, L. Influence of differentiated key-pressing on auditory cortical evoked response in man. Physiology and Behavior, 1966, 1, 351-357.

Changing the difficulty of a task requiring a decision whether to press a key or not, the latencies of the negative (N_1) and positive (P_2) peaks and the amplitudes of $P_1 - N_1$, $N_1 - P_2$ and $P_1 - P_2$ of the auditory cortical evoked response were measured in 10 Ss. The startle reflex, GSR, and the verbal report of the Ss were also evaluated. The latencies and amplitudes of the peaks N_1 and P_2 changed independently according to the difficulty of the task, displaying a different dependence on the type of attention of the Ss to the acoustic stimulus.

- 1036 Sakano, N., & Pickenhain, L. Influence of attention and/or an active motor reaction of the subject on latency and amplitude of the auditory cortical evoked response (ACER) in man. Psychologia: An International Journal of Psychology in the Orient, 1966, 9, 131-133.

Changing the difficulty of a task requiring a decision whether to press a key or not, the latencies and amplitude of the 1st negative peak at vertex (N_1) and the 2nd positive peak (P_2) of the ACER and the startle reflex were measured. The latencies and amplitudes of N_1 and P_2 changed independently, i.e., N_1 is correlated with the attentive process (selective or diffuse), whereas P_2 is correlated with the participation of the motor system which by instruction is connected with the click.

- 1037 Salvendy, G., & Stewart, G. The prediction of operator performance on the basis of performance tests and biological measures. Proceedings of the 19th Annual Meeting of the Human Factors Society, 1975, 457-466.

1. The hypothesis is supported that by combining scores of test performance and biological measures significant increases in the concurrent validity of personnel selection tests would emerge.

2. The most powerful predictors of job performance are the absolute values of the standard deviation of basal interbeat intervals. It has a -0.45 concurrent validity.

3. The concurrent validities of the performance measures were 0.47, 0.61 and 0.66 multiple correlations for 4, 10 and 16 predictors with the criteria of production performance. None of these multiple correlations are statistically significant at the 5 percent level.

4. The concurrent validities of the biological measures were 0.65 ($P < 0.01$), 0.72 ($P < 0.05$) and 0.74 (not significant) multiple correlations with the criteria of production performance.

5. The combined biological measures with test performance scores predicted significantly more effectively the production performance than using only test performance measures. The concurrent validities were 0.72, 0.91 and 0.99 multiple correlations for 8, 16 and 30 variables.

6. Caution must be exercised in interpreting the true magnitude of the multiple correlations because of the relatively large number of variables entering into the equation for a relatively small number of subjects participating in this study. Hence, shrinkage statistics should be utilized for the true interpretation of the magnitude of the multiple correlations.

7. The individual production performance of 35 female bench operators could be predicted within $\pm 2\%$ from their combined test performance and biological scores.

1038 Sanders, R. M., & Wood, D. M. Anticipatory heart-rate changes: Environmental vs self-produced mediation of the time between a warning stimulus and the required response. Psychological Reports, 1969, 25, 671-674.

Nine Ss participated in an experiment comparing anticipatory heart-rate changes to two different kinds of reaction times. Ss were paid for pushing a button within 500 msec of a signal (simple reaction time) and were paid for pushing a button within ± 250 msec of 5 sec after a signal (internally mediated reaction time). For all Ss and under both conditions, the heart-rate was observed to decelerate during at least the 2 sec prior to the response being made. However, return to an accelerating phase was delayed by approximately 2 sec for the internally mediated reaction time condition.

1039 Sandler, I. S., & Schwartz, M. Evoked responses and perception: Stimulus content versus stimulus structure. Psychophysiology, 1971, 8, 727-739.

These experiments tested whether waveform changes in evoked responses to visual stimuli could be produced by changes in stimulus content independent of changes in stimulus structure. Ambiguous figures were employed to manipulate content without changing structure. To manipulate structure without changing content, stimuli were presented in original and mirror image versions or versions varying in size. The results indicated that evoked responses can be modified by content differences independent of any structural changes, but it was suggested that content related changes might reflect the operation of more general psychological processes such as attention and emotion.

1040 Sanford, A. J. A periodic basis for perception and action. In W. P. Colquhoun (Ed.), Biological rhythms and human performance. London and New York: Academic Press, 1971

The evidence reviewed demonstrates that in some circumstances a relationship between observable alpha activity and performance is a reality. The strongest relationship appears to be that between alpha period and reaction time. Work related to alpha phase is less satisfactory, not because of a total failure to demonstrate a relationship, but because the effects obtained are so small and are subject to day by day variation and because certain simple predictions have not been borne out in practice. Attempts to account for reaction time-phase relationships are not, as they stand, explicable in terms of a "perceptual moment" theory such as that of Stroud. The correlations of alpha frequency with reaction time have been used to postulate something analogous to a computer "cycle time" in the human brain, but there has been no real proof of this; it remains an intriguing possibility.

- 1041 Santamaria, A. Background music on a mental task, influence of playing time on performance and heart variability. Unpublished masters thesis, Kansas State University, 1970.

An alphabetical filing task was performed while stimulating music was played 10%, 25% and 50% of the time. Six male subjects worked in the three conditions for 150 minutes and five criteria were recorded: time per card filed, errors, heart rate, heart variability and galvanic skin response. Although some of the differences were not statistically significant, results tend to show that 25% was the best condition. A lower percentage of music seemed to increase the heart variability and heart rate but at the same time tended to decrease the time per card. A higher percentage of music tended to decrease physiological stress (heart variability and GSR) but at the same time tended to decrease efficiency.

- 1042 Satterfield, J. H. Evoked cortical response enhancement and attention in man. A study of responses to auditory and shock stimuli. Electroencephalography and Clinical Neurophysiology, 1965, 19, 470-475.

1. In 47 consecutive normal subjects the average evoked cortical response to both click and shock stimuli was measured when the subject was attending to one while ignoring the other stimulus.

2. The amplitude of the evoked response to both click and shock was enhanced when the subject attended to the stimulus, whereas the response to which he was not attending tended to be suppressed. These changes were statistically significant at the $P < 0.001$ level.

3. In five subjects the peripheral nerve response and the cortical response to shock were simultaneously recorded. In no case could the enhancement of the average cortical response with attention be accounted for by similar augmentation of the average peripheral nerve response.

- 1043 Satterfield, J. H., & Cheatum, D. Evoked cortical potential correlates of attention in human subjects. Electroencephalography and Clinical Neurophysiology, 1964, 17, 456-457. (Abstract)

When attending to the stimulus to the right wrist, the response to that stimulus was reduced in amplitude while the response to the left wrist stimulus remained unchanged. Similar results were obtained when the subject attended to the stimulus to the left wrist; i.e., the response to the stimulus to which the subject was attending (left wrist stimulus) was reduced while the response to which the subject was not attending (right wrist stimulus) was unchanged. These findings were statistically significant at the 0.05 to 0.01 level in five subjects.

- 1044 Saxon, S. A., & Dahle, A. J. Auditory threshold variations during periods of induced high and low heart rates. Psychophysiology, 1971, 8, 23-29.

The study was designed to test Lacey's and Callaway's contention that individuals respond differently to sensory sensitivity tasks under conditions of high and low heart rates. A Bekesy audiometry threshold tracing was obtained from subjects after a period of inactivity and after a period of activity. The results indicated that the subjects' auditory thresholds for the 1000 Hz tone were significantly less acute under the condition of induced higher heart rates. Although the data collected is correlational in nature the possibility that the higher rate results in reduced sensory sensitivity from a causal point of view is suggested. Although Lacey's and Callaway's formulations are not synonymous with the traditional theories of activation, it is highly probable that their formulations may be merely delineating the mechanisms by which extreme arousal results in impaired performance.

- 1045 Sayers, B. McA. The analysis of cardiac interbeat interval sequences and the effects of mental work load. Royal Society of Medicine, 1971, 64, 707-710.

It is now clear that there are three major factors contributing to the interval signal: quasi-oscillatory fluctuations, which I believe originate in the body temperature-regulating system; vasomotor oscillations probably originating in the blood-pressure regulating mechanism; and respiratory effects. These three factors are arranged in ascending order of the rate of fluctuations which they generate, but only the two faster fluctuations are relevant here. Vasomotor oscillations with a major periodicity of about 10 seconds in man (about 14 intervals or so at 80 beats/min average) are commonly seen in dynamic blood pressure records as well as in heart rate, but the system is also quasi-oscillatory in that certain postural changes, certain respiratory manoeuvres and sometimes - of special interest here - work loads, can modify or abort the oscillations. (It appears that the influence of work load on the fluctuations is most important in the heart rate signal but not in blood pressure; hence we consider only the cardiac interbeat intervals here.) Respiratory effects are also easily discerned because a respiratory rate of 15 per minute means an average respiratory period lasting about 4 seconds (or say 5 intervals) and so a broadly periodic fluctuation at this rate is probably due to respiration; objective procedures are available for confirming this presumption.

These effects can be separated and clarified by considering the set of interval patterns that result when the interbeat interval record is band filtered - only those fluctuations are retained which fall into a predetermined range of rates.

- 1046 Sayers, B. McA. Analysis of heart rate variability. Ergonomics, 1973, 16, 17-32.

Spontaneous variability of heart-rate has been related to three major physiological originating factors: quasi-oscillatory fluctuations thought to arise in blood-pressure control, variable frequency oscillations due to thermal regulation, and respiration; frequency selective analysis of cardiac interbeat interval sequences allows the separate contributions to be isolated. Using this method, a laboratory and field study of the effects of mental work load on the cardiac interval sequence has been carried out. Results suggest that mean heart rate and variance are unreliable measures, but that consistent changes in interval spectrum occur; these have been traced to alterations mainly in the 0.1 Hz region, perhaps originating with changes in the patterns of respiration which interact with the 0.1 Hz vasomotor activity.

- 1047 Sayers, B. McA. Physiological consequences of informational load and overload. In P. H. Venables & M. J. Christie (Eds.), Research in psychophysiology, London: Wiley, 1975.

All physiological signals are subject to spontaneous variation for two reasons; the operation of statistical sampling effects, and the influence of altering biological processes that affect the signal. Against the background of spontaneous variability of the cardiac interval signal and its contributing components, the main effects that commonly occur when a subject undertakes a difficult information-handling task are as follows. First, the signal power (variance) often decreases, but not invariably. (Improved sensitivity in this measure can be obtained by excluding very slow fluctuations having periods above 25 sec.) Certainly however, there is a redistribution of signal power amongst available spectral components; this is reflected in changes of the cardiac interval auto-correlation sequence, but this particular measure is inconvenient to compute and interpret and is also subject to unattractive statistical sampling variations. Close scrutiny of the amplitude spectra instead, and of spectral variations, indicates several reasons for the changes that occur: respiratory rate, depth or pattern variations, alterations in the recurrence periods of the bursts of roughly 0.1-Hz oscillations that are believed to originate in the blood-pressure vasomotor system and reductions in the interactions between vasomotor fluctuations believed to be of thermo-regulatory origin and fluctuations of respiratory origin. When the task is too difficult to be carried out without a significant increase in error rate, it is also observed that pressure-vasomotor oscillations cease altogether, and the interactions that indicate an (incidental) influence due to thermo-regulatory fluctuations on the way respiration appears to affect cardiac intervals can no longer be identified. No effects on the components believed to originate in the thermo-regulatory process have been seen in any subject and there may be advantages, for this reason, in eliminating this component altogether from the signal.

- 1048 Schacke, G., & Weitowitz, R. Zur Erfassung Psycho-Vegetativer Belastungen am Arbeitsplatz mit Hilfe der Radiotelemetrie. [Radiotelemetric measurement of psychovegetative stress at work.] Arbeitsmedizin-Sozialmedizin-Arbeitshygiene, 1971, 6, 259-262.

Bibliographical review of the present state of knowledge of the significance of heart rate as an indicator of vegetative tonus and, indirectly, of psychic stress. The authors present some fundamental results of their own investigations relating to typical cases; an executive; a piece-worker; a gynecologist during operations and simple consultations. They consider the further development of methods used and discuss the index of frequency increase, which is mathematically defined and lends itself to statistical treatment, and which can be calculated by means of a small analogue computer from the heart rate profile obtained telemetrically.

1049 Schaefer, K. E. Research on the diurnal periodicity of physiological functions and of performance level; including studies of the effects of removing, or of changing the period or the phase of, environmental time indicators (R-24). Groton, Conn.: Naval Submarine Medical Center, Oct. 1964. (NTIS No. AD-703 102)

This preliminary evaluation of the results does not take into account all the data obtained. A major part of these data is presently being processed for computer analysis of power spectra. It is therefore not possible to discuss, at the present time, the effects of isolation in a constant environment on details of circadian cycles and cycles of higher frequency. However, the trends are quite clear. Our results are in general agreement with those of Aschoff who first established in man synchronous free-running of circadian cycles of body temperature and urinary excretion under conditions of a constant environment. We established a synchronous free running of four additional cycles, respiratory rate, pulse rate, lung functions and saliva electrolytes. It was also found that the return to a normal synchronization of body cycles with environmental time givers produced a significant stress, leading to dissociation of previously synchronized body functions. The recovery period of 3 1/2 days was, unfortunately, too short to evaluate the full significance of these findings. Marked individual differences were observed in the amplitude of cycles. Only the subject with a larger amplitude of cycles showed a decrease of the amplitude during isolation. The psychomotor performance data show a more clearly expressed periodicity in the subject who exhibits more pronounced physiological cycles with larger amplitudes. The performance levels as such did not decrease during the eight-day isolation period in which the circadian cycles shifted 13 hours away from local clock time.

1050 Schafer, E. W. P. Brain responses to television reflect program interest. Psychophysiology, 1977, 14, 115. (Abstract)

One can record reliable, event-related brain potentials from people while they watch television by computer-averaging electrocortical responses evoked by flickers electronically inserted in the TV picture.

The results of three separate experiments on a total of 30 young adult viewers studying the effects of program interest on TV-evoked potentials (TVEPs) all revealed significantly smaller amplitude late components for vertex TVEPs when people watched interesting in contrast to dull programs, e.g., "M*A*S*H" versus "Meet the Press." Control experiments measuring eye movements indicate that peripheral factors could not account for the reduced TVEP amplitude during interesting programs.

The late components of event-related potentials from the vertex appear to reflect the workings of an active attentional process within the brain. Studies demanding selective attention to the evoking stimulus report late components of increased amplitude. Conversely, present findings suggest that increased interest focused on a TV presentation creates reduced attention to the evoking probe stimuli with consequent amplitude reduction for late TVEP components. Present findings also parallel the results of animal and human experiments showing reduced evoked potential amplitude accompanying distraction.

The television-evoked potential technique provides a method for studying the human brain's attentional and cognitive mechanisms at work under more real-life conditions than previously. The technique could also prove useful for rating, without conscious bias, the interest value of any material shown on television.

- 1051 Schechter, G., & Buchsbaum, M. The effects of attention, stimulus intensity, and individual differences on the average evoked response. Psychophysiology, 1973, 10, 392-400.

The effects of shifting attention toward or away from visual or auditory stimuli of varying intensities were studied using average evoked responses (AERs) in 24 normal human volunteers. Ss were asked to attend to visual or auditory stimuli of four intensities (randomly presented) or to ignore the lights and tones and do mental arithmetic. For visual stimuli, attentional effects were largest at low intensities whereas for auditory stimuli equal effects were shown across intensities. Similar individual rates of increase of AER amplitude with increasing intensity were observed for both visual and auditory stimuli when attentional conditions were controlled. These results suggest that some general intensity processing response is reflected in the AER and that it is important to control attention in AER experiments.

- 1052 Schell, A. M., & Catania, J. The relationship between cardiac activity and sensory acuity. Psychophysiology, 1975, 12, 147-151.

The relationship between cardiac activity and sensory acuity suggested by Lacey and Lacey was tested by recording heart rates of Ss attempting to detect a threshold-level visual stimulus. Heart rate decelerations during a warning tone preceding the threshold stimulus were found to be greater on hit trials than on miss trials, supporting the suggested relationship.

- 1053 Schell, A. M., & Grings, W. W. Judgments of UCS intensity and diminution of the unconditioned GSR. Psychophysiology, 1971, 8, 427-432.

Perceptions of UCS intensity associated with UCR diminution in a classical conditioning situation were investigated using a procedure in which S matched the loudness of a tone of variable intensity to that of a white noise UCS. Changes in the subjective loudness of the UCS paralleling the changes in UCR magnitude observed with CS-UCS pairings were found.

- 1054 Schifflett, S. G. An electrocortical model of bimodal vigilance performance (Doctoral dissertation, Texas Tech University, 1975). Dissertation Abstracts International, 1975, 36, 3099B. (University Microfilms No. 75-26, 858)

The results indicated a significant decrease across time for all performance and physiological dependent variables. The slower stimulus rate groups had a significantly higher percentage of correct detections, more false alarms, and slower reaction times than the faster stimulus rate groups. The signal detection measure of d' (sensitivity) remained unchanged across time while beta (cautiousness) increased for both event rate groups.

The physiological components of the model were significantly correlated with the changes in performance. The model discriminated between event rate groups, detected signals, and missed signals. Signal rates had a minimal effect upon physiological and performance measures.

The results were discussed in terms of selective attention, expectancy, arousal, and decision making theories of vigilance. It was concluded that the model showed promise as a useful research paradigm for further studies in sustained attention.

- 1056 Schmidtke, H. Reaktionen des Menschen auf Beobachtungs und Wachsamkeitsaufgaben. [Reactions of individuals in terms of observation and vigilance performance.] Verhandlungen der Deutschen Gesellschaft für Arbeitsschutz, 1969, 10, 132-140.

An attempt was made to characterize two types of modern occupations differing with regard to the number of stimuli requiring reaction supplied per time unit. It was possible to prove that in occupations with high stimulus density, great variation in time of the performance must be expected, leading for some jobs to inadmissibly high error frequency. On the other hand a type of position in highly mechanized and automatized manufacturing units was indicated which with respect to the frequency of processing stimuli requiring reaction rather tends to make less demands on persons. It was possible to show that the decrease in performance in this type of job takes place because, to a great extent, the reticular activation level of the person and therefore also his vigilance decreases for want of stimulation. Possibilities of preventing this lack of stimulation are discussed.

- 1056 Schmidtke, H. Wachsamkeitsverhalten und Leistung bei der Überwachung technischer Systeme. [Vigilance and performance in monitoring technical systems.] In Man and Ship III. Symposium presented at the 10th Annual meeting of the Naval Medical Institute, and the 11th Work Session of the Navy Health Officers, Keel, 1972.

Since cortical activity is accessible to quantitative analysis through EEG measurement and since there are characteristic changes of the EEG curves in the course of the sleep and wakefulness continuum, it should be possible through a detailed analysis of these spontaneous EEG to forecast the wakefulness behavior of a person. Taking as a starting point the researches of Walter and Associates in connection with the NASA Gemini and Apollo Projects, Böttge and Holoch of my institute, were able to demonstrate that such a forecast is possible. If instead of the conventional methods of analysis for non-periodic oscillations (amplitude, frequency) derivative methods were used, such as performance density spectrum, coherence and phase, it then becomes possible with relatively few parameters from the period 2.3 seconds before a critical stimulus, to predict with a very high probability whether this stimulus will be reacted to or not.

- 1057 Schmidtke H. Zur quantitativen analyse der psychophysischen beanspruchung bei der bedienung komplexer dynamischer systeme. [Quantitative analysis of psychophysical stress in operating complex dynamic systems.] Paper presented at the 14th meeting of the committee "Anthropotechnik" of the Deutsche Gesellschaft für Luft-und Raumfahrt, Munich, November 1973. [Also abstracted in Scientific and Technical Aerospace Reports (Report No. DLR-Mitt 74-19).]

The relative value of physiological and psychological factors in determining workload in complex situations is discussed with a view to establishing quantitative methods of analysis.

- 1088 Schmitt, O. H. Biophysical models for studying work and fatigue. In E. Simonson & P. C. Weiser (Eds.), Psychological aspects and physiological correlates of work and fatigue. Springfield, Ill.: C. C. Thomas, 1976.

Finally, we should realize that covariance of real control parameters with other available but not directly involved variables gives a possible non-destructive access to psychological status. In one humble attempt now begun in our laboratory, we have observed, by our technique of voluntary cardio-respiratory synchronization, the day by day variation, in an individual, of the cardio-respiratory coupling coefficient along a regression trajectory characteristic of the individual. This could be a measure of internal system status variation readily accessible by this method, but only reachable by profound, possibly dangerous stressing by traditional techniques. We would hope that a whole family of nondestructive covariant tests like this will emerge by which we can examine the status of an individual and the margin of stability within his several feed-forward and feedback loops, both at one hierarchical level, and within the control of hierarchical level dominance and internal linguistic choice.

- 1089 Schnore, M. M. Individual patterns of physiological activity as a function of task differences and degrees of arousal. Journal of Experimental Psychology, 1959, 58, 117-128.

The present results further support earlier work which found physiological measures singularly useful in providing objective and reliable indicants of arousal. Fifty-six per cent of Ss showed significant correlation among the physiological measures. There were four measures (heart rate, blood pressure, respiration rate, and right forearm muscle tension) which consistently differentiated between high and low arousal conditions. Present evidence suggests, therefore, that these four measures may be maximally useful as indicants of arousal, at least within the range of arousal levels studied. Although data from other experimental situations are required in order to reach a firmer conclusion concerning the relative usefulness of these measures, it seems certain that several indices are superior to only one or two in gauging level of arousal.

- 1090 Schroeder, S. R., & Holland, J. G. Operant control of eye movements during human vigilance. Science, 1968, 161, 292-293.

Eye movements were used as a criterion of observing responses in a vigilance task. Time on watch and signal rates similarly affected both eye-movement rates and percentage of detections. Observing rate may account for detection data, and may be a more stable measure of vigilance than detection rate is, especially when very few signals occur.

- 1091 Schwartz, M. Averaged evoked responses and the encoding of perception. Psychophysiology, 1976, 13, 546-553.

This paper reviews the hypothesis that averaged evoked response (AER) recordings encode the perception of stimulus content. AERs may be altered by changing subjects' expectancies, attention, affect, etc. AERs may also be altered by differences in the physical parameters of the eliciting stimuli. But if perception is viewed as the processing of the specific informational content of the stimuli, there is no convincing evidence that AERs encode perception. Thus, AERs appear to be a summary of the activity of stimulus feature detectors and the results of decisions concerning the salience or importance of that information--- AERs represent general operations not the specific content of the information being processed.

- 1062 Schwartz, M. On testing specific hypotheses about subliminal perception: A reply to Shevrin. Psychophysiology, 1976, 13, 27-31.

Schwartz and Rem (1975) reported that they could find no evidence that averaged evoked responses discriminate between two stimuli presented for durations that were either subliminal or supraliminal for discriminating the stimuli behaviorally. Shevrin (1975) has criticized this conclusion. This paper argues that Shevrin's criticisms are factually and theoretically erroneous. In addition, a reanalysis of the data, following Shevrin's suggestions, confirms the conclusions originally drawn - there is no evidence that averaged evoked responses discriminate between either subliminal or supraliminal stimuli.

- 1063 Schwartz, M., & Rem, M. A. Does the averaged evoked response encode subliminal perception? Psychophysiology, 1975, 12, 390-394.

In a series of studies, Shevrin and his colleagues have reported that the effects of subliminal perception are encoded in the average evoked response. Our experiment was a more stringent test in that we (1) collected both physiological and behavioral data in the same trials, (2) attempted to minimize criterial differences in the employment of physiological and behavioral responses, and (3) behaviorally verified conditions designed to be subliminal. Two stimuli were presented tachistoscopically in a given trial, separated by 1 sec; over blocks of trials, exposure duration for the stimuli was 3, 7, 15, and 30 msec. At 3 msec exposure, all subjects detected the stimuli but could not discriminate between them; discrimination increased with increasing exposure duration. But at no exposure duration did average evoked response measures discriminate between the stimuli - the only changes in evoked response measures were those due to increasing stimulus energy. Thus, there was no evidence for either subliminal or supraliminal discrimination of stimulus content by the AER.

- 1064 Scott, D. F., Hoffmann, H., & Bickford, R. Changes in summated visual potentials (lambda waves) during mental tasks using the Stroop test. Perceptual and Motor Skills, 1967, 25, 993-996.

In normal Ss, a parietal-occipital located response (lambda wave) is evoked by scanning a printed block and word material (colored, and black and white) of the Stroop test. When this response is summated with a computer triggered by the eye movement, a highly reliable triphasic wave appears which can be subjected to accurate latency and amplitude measurements. The shortest latency of this response was observed when blocks vs words were presented, but there were no differences in latency in spite of increasing difficulty of material. This indicates that the structure of the material rather than mental activity affected the latency. Likewise, no changes were noted with colored vs black material. There was, however, a small increase in amplitude of the lambda wave response in the most difficult (word interference) task—a result that could be attributed equally to increase of muscle potentials and to the effect of mental activity.

- 1065 Scott, W. E., Jr. Activation theory and task design. Organizational Behavior and Human Performance, 1966, 1, 3-30.

Performance decrements and dissatisfactions at the work place have long been observed but have not been adequately explained. Activation research and selected studies of work behavior are reviewed to show that decrements in performance may be better understood in the light of recent neuropsychological findings. This review indicates that activation theory and the research upon which it is based anticipates behavior related to variations in task design and suggests new avenues of investigation for those interested in the determinants of work behavior.

- 1066 Seales, D., & Lindsley, D. B. Modification of human visually evoked potentials by complexity and cerebral lateralization of information processing. Electroencephalography and Clinical Neurophysiology, 1975, 38, 101. (Abstract)

Three tasks employed the same letter-pair stimuli, e.g., HH or bD. Subjects responded when they saw a stimulus (SIGHT task), or when they determined whether the two letters were the "same" or "different" in either size or name (SIZE and NAME tasks, respectively). EEG was recorded from vertex and symmetrical occipital and parietal sites (linked earlobes reference).

Reaction time increased from the SIGHT to the SIZE to the NAME task. The P2-effect occurred with the increase in task complexity from the SIGHT to the SIZE tasks, but did not increase further in the more complex NAME task. The P2-effect was maximal at occiput, and did not lateralize. N2(500-750 msec) showed hemispheric asymmetry.

- 1067 Shagass, C., & Schwartz, M. Evoked cortical potentials and sensation in man. Journal of Neuropsychiatry, 1961, 2, 262-270.

Results of initial experiments with a new psychophysiological method are reported. This method permits measurement of cortical potentials evoked by sensory stimulation and recorded from scalp electrodes; such potentials are not detectable in the usual electroencephalogram (EEG). Potentials evoked by visual and electrocutaneous stimulation are described. They consist of a relatively constant initial response of brief latency and duration, followed by several waves which may continue for relatively long periods and are more variable. The secondary waves seem to be influenced by psychological factors. The amplitudes of the potentials are a function of stimulus intensity. The first sign of a primary response occurred at the sensory threshold; subthreshold stimuli evoked no cortical response. This indicates that the evoked potential may be an objective sign of sensory awareness in the unanesthetized animal. Cortical excitability cycles were successfully measured by the method of paired stimuli. The method offers interesting possibilities for studying the psychological correlates of directly measurable states of cortical excitability.

- 1068 Shagass, C., Straumanis, J. J., Jr., & Overton, D. A. Electrophysiological recordings in the reaction time experiment: Exploratory studies for possible psychiatric research application. Biological Psychiatry, 1972, 5, 271-287.

Visual evoked response amplitude was greater and latency tended to be shorter when reaction time was faster. The intraindividual relationship measures were not stable on a retest and did not appear to characterize the individual. This instability may have been a major factor influencing the generally negative results obtained in correlating the measures with personality and intelligence test scores in nonpatients and in failure to demonstrate patient-nonpatient differences. A hitherto unsuspected intraindividual relationship between blink latency and reaction time was demonstrated, probably reflecting involvement of the eyes in the motor response pattern.

- 1069 Shagass, C., & Trusty, D. M. Somatosensory and visual cerebral evoked response changes during sleep. In J. Wortis (Ed.), Recent advances in biological psychiatry (Vol. 8). New York: Plenum Press, 1966.

To compare cerebral evoked responses during various stages of sleep, averaged somatosensory and/or visual responses were recorded during sleep in forty tests with twenty-nine subjects. The electroencephalogram was classified as to stage of sleep and the first twelve peaks of each evoked response were measured for latency and amplitude. Results were: (1) The late visual after-rhythm disappeared with onset of sleep. (2) Latencies became systematically more prolonged as sleep deepened. (3) Amplitudes of initial components increased with deep sleep. (4) Amplitudes of components following the initial ones tended to decrease. (5) Responses during the rapid-eye-movement phase of sleep (REM) were indistinguishable from those of stage I and significantly different from waking responses. (6) Latencies of later components continued to be prolonged after waking from deep sleep, returning to presleep levels gradually. Evoked-response characteristics may provide useful indicators of level of awareness.

- 1070 Sheatz, G. C., & Chapman, R. M. Task relevance and auditory evoked responses. Electroencephalography and Clinical Neurophysiology, 1969, 26, 468-475.

Studied the influence on auditory averaged evoked potentials (AEPs) of information processing during problem solving in 9 Ss. S compared 2 relevant stimuli and determined which was lower in pitch. AEPs tended to have 2 positive peaks with latencies of approximately 150 and 300 msec. The amplitudes of these peaks (Peaks 1 and 2) were measured and the influence of task relevance, stimulus class, and presentation order within a trial was evaluated statistically. The AEPs of the tones and noises were similar. The task relevance of the stimuli had a marked effect on the AEPs, the magnitude depending greatly on the order of the stimuli within a trial. Differences were related to postperceptual processing. Results are discussed in relation to information processing, attention, stimulus gating, uncertainty, and general state variables.

1071 Shevrin, H. Does the averaged evoked response encode subliminal perception? Yes. A reply to Schwartz and Rem. Psychophysiology, 1975, 12, 395-398.

An attempt by Schwartz and Rem (1975) to replicate a series of studies by Shevrin and coworkers purporting to show that the average evoked response encodes subliminal perception is found to be limited as a replication in a number of ways. Despite substantial departures in method and procedures Schwartz and Rem report a potentially confirmatory finding: AER cross correlations between different stimuli are significantly lower than for similar stimuli in an exposure level (3 msec) in which subjects fail to make an above chance verbal discrimination. In view of the important theoretical issues involved concerning the nature of subliminal perception and unconscious cognitive processes this cross correlation finding should be further investigated. Suggestions are made as to how this might be done.

1072 Shevrin, H., & Rennick, P. Cortical response to a tactile stimulus during attention, mental arithmetic and free associations. Psychophysiology, 1967, 3, 381-388.

Attention to a stimulus appears to be associated with amplitude fluctuations in 100-msec or later components of the cortical compound evoked potential (CEP). In this study, changes in amplitude and latency of the CEP to the same tactile stimulus were investigated under three conditions: attention, free associations, and mental arithmetic. In the attention condition Ss were asked to estimate varying time intervals between stimuli on a 2- to 6-sec scale. Ss were 12 pairs of twins. It was found that the amplitudes of two negative electrocortical potentials were greater when Ss were estimating lengths of time intervals between stimuli than during free association or mental arithmetic. Peak latency of the second negative potential was greater in attention than in the other two conditions. Free association CEPs were distinguished by the incidence of alpha bursts. The results support the hypothesis that attention is associated with certain parameters of the electrocortical response and suggest which aspects of the electrocortical response are most likely to be related to attention.

1073 Shipton, J., & Walter, W. Les relations entre les activites alpha, les modes de pensee et les affinites sociales. [The relations between alpha activity, modes of thought and social affinities.] Electroencephalography and Clinical Neurophysiology, 1957, Supplement 16, 185-202.

When the methods of analysis and display described in the previous paper are used in the course of a psycho-physiological experiment, the personal features of a record are emphasised and it is possible to follow the changes in distribution of the several alpha components which occur either spontaneously or during the performance of diverse tasks.

Information collected in this way permits a classification of normal subjects based on the responsiveness or persistence of the various alpha components. This classification seems to correspond with psychological estimates of mental imagery and of versatility; it can be elaborated by the inclusion of other physiological data such as records of breathing, speech, muscular tension, heart rate, skin resistance and the like.

It has been noticed that a subject in one class tends to associate more readily with someone in the same class than with someone in another class. In this way it is possible to recognize "supplementary pairs" (that is, subjects whose alpha type and way of thinking are similar and who tend to agree in their tactical habits of behaviour, even if they have different strategic aims; such couples are mutually attractive but tend to make the same sort of mistakes) and "complementary pairs" (that is subjects who differ in their E. E. G. and in their ways of thinking and have different tactics even when in strategic agreement; such couples are not readily attracted to one another but tend to limit or correct one another's mistakes). It is intended to apply this method to the study of more complex situations and larger groups.

- 1074 Shor, R. E., & Thackray, R. I. An apparatus to study continuous discrimination performance as a function of level of cerebral vigilance. Psychophysiology, 1970, 6, 492-495.

An apparatus was developed to study human discrimination performance as a function of the arousal continuum. The apparatus was designed to provide Ss with an undemanding, repetitive, and monotonous discrimination task over long periods of time. A functional description and circuit details are given.

- 1075 Shucard, D. W., & Callaway, E., III Auditory evoked potential amplitude and variability: Effects of task and intellectual ability. Journal of Comparative and Physiological Psychology, 1974, 87, 284-294.

The effect of stimulus uncertainty, attention, interstimulus interval, and amount of time in the experimental situation on the average auditory evoked potential was investigated in 2 groups of subjects separated according to differences in intellectual ability. The results indicated that, in general, evoked potential amplitude was greater (a) for the first part of the experimental test session compared with the later part, (b) for conditions requiring attention compared with nonattending conditions, (c) for the stimulus following the long (rather than short) interstimulus interval, and (d) for conditions of greatest stimulus uncertainty. Also, evoked potential variability was found to increase as amplitude increased. Evoked potential differences between experimental groups suggested divergence both in strategies employed and in effects of experimental conditions on these groups.

- 1076 Shucard, D. W., Shucard, J. L., & Thomas, D. G. The auditory evoked potential and the assessment of cerebral lateralization of cognitive processing. Psychophysiology, 1977, 14, 91. (Abstract)

In this investigation, the auditory evoked potential (AEP) was used to probe hemispheric functioning while subjects were engaged in processing auditory information. This study was unique in that it used pairs of irrelevant tone pips to generate AEPs during the course of auditory information processing. This paradigm allowed for the study of the effects of orientation on hemispheric laterality of function while controlling for attentional factors and movement.

Twelve strongly right-handed subjects between the ages of 21 and 28 participated in three tasks: detection of clicks embedded in white noise, detection of key words occurring in verbal passages, and detection of recurring themes occurring in musical selections. Task performance was closely monitored and recorded for each condition. Left and right temporal AEPs were recorded separately for tone 1 and tone 2 of the pairs of tone pips which were superimposed on the auditory information presented for processing during each of the three tasks. Only data from subjects who performed adequately on all three tasks were included in the final analysis.

Significant differences in left versus right hemisphere AEP amplitudes occurred as a function of task, with the greatest amplitude occurring in the hemisphere thought to be involved in the ongoing cognitive processing. Right-left AEP amplitude comparisons across tasks indicated that during the verbal task the left hemisphere AEP was higher in amplitude than the right; whereas, for the musical task, the right hemisphere AEP was higher than the left. These results were most pronounced for the second of the two tone pips.

The findings indicate that the AEP used as described may provide a powerful technique for the study of various facets of lateralization of cognitive processing in intact individuals.

- 1077 Siddle, D. A. T. The orienting response and distraction. Australian Journal of Psychology, 1971, 23, 261-265.

The effect on right ear sensitivity of a distracting stimulus presented to the left ear was investigated in 20 male Ss. Two right ear performance change scores were derived—immediate decrement, and rate of performance recovery with repeated presentations of the distractor. The results indicated that immediate performance decrement was positively related to initial orienting response size to an auditory stimulus, while rate of performance recovery was found to relate to the speed with which the orienting response to an auditory stimulus habituated.

- 1078 Siddle, D. A. T. Vigilance decrement and speed of habituation of the GSR component of the orienting response. British Journal of Psychology, 1972, 63, 191-194.

The present study was designed to investigate the relationship between auditory vigilance performance and speed of habituation of the GSR component of the orienting response (OR) to auditory stimuli. Fast habituators ($n = 7$) displayed a greater rate of vigilance decrement than slow habituators ($n = 7$), suggesting a more rapid onset of a phase of low arousal in these subjects.

- 1079 Siddle, D. A. T., & Mangan, G. L. Arousability and individual differences in resistance to distraction. Journal of Experimental Research in Personality, 1971, 5, 295-303.

Two experiments are reported which investigated the role of arousability differences in ability to concentrate attention during distraction. Experiment 1 differentiated Ss in terms of the manner in which performance on a central visual task was affected by a distracting auditory stimulus. The main predictors of distractibility were the orienting response parameters of initial amplitude and speed of habituation in the distracting modality, and neuroticism. Experiment 2 was designed to test whether resistance to distraction and arousal level are related in a curvilinear fashion. This hypothesis was supported. These results also indicated that amount of improvement or disruption in performance of the central task, occurring during low and high intensity distraction, was related to the size of the phasic arousal response evoked by distractor onset.

- 1080 Siegfried, J. B., Tepas, D. I., Sperling, H. G., & Hiss, R. H. Evoked brain potential correlates of psychophysical responses: Heterochromatic flicker photometry. Science, 1965, 149, 321-323.

The relation between the amplitude of evoked brain potentials in man and the relative luminance of two flicker components of different color was determined. The function, which is U-shaped, has a minimum which occurs near the point of equal luminance as judged by the psychophysical method of flicker photometry.

- 1081 Silverman, A. J., Cohen, S. I., & Shmavonian, B. M. Investigation of psychophysiologic relationships with skin resistance measures. Journal of Psychosomatic Research, 1959, 4, 65-87.

Using a newly designed, highly stable and sensitive galvanic skin resistance meter it was possible to record and discriminate fluctuations in skin resistance of about 20-50 ohms, at the same time recording grosser shifts in the basal skin resistance. Preliminary work with the instrument and various drugs acting on the CNS suggested certain relationships with CNS arousal:

(1) The number of 'spontaneous' rapid GSR's increases in direct proportion as the individual is alerted or aroused.

(2) The amplitude of the GSR response to specific external stimuli increases with alerting but decreases when the individual is in a hyper-aroused state.

This series was designed to explore the applicability of this finding to psychophysiologic investigations.

In three separate experiments, subjects were exposed to the gross vascular stress of the human centrifuge. While GSR was being recorded before, during and after the hypotensive stress, they were asked to perform a continuous tracking task. Results agreed with the hypothesis. When the GSR suggested moderated alerting, psychomotor performance improved; when hyperalerting was indicated by the GSR, performance declined.

One series of experiments (still in progress) demonstrated that response to threshold stimuli related directly to 'level of arousal' as measured by number of non-specifics. Amplitude of responses to these stimuli was also directly related to number of nonspecifics.

- 1082 Simon, C. W., & Emmons, W. H. EEG, consciousness, and sleep. Science, 1956, 124, 1066-1069.

One important practical application of the information in this paper is in the study of factors affecting sleep and rest. In addition to the more classical measure of time (or length of sleep), electroencephalographic patterns can provide a means of continuously measuring depth of sleep without disturbing the subject. Using a two-dimensional measure - length and depth - is a more sophisticated approach to certain problems of sleep and rest and can be expected to yield more satisfactory conclusions. Such problems have important implications for both military and civilian use.

- 1083 Simonova, O., & Legewie, H. EEG changes under different conditions. Electroencephalography and Clinical Neurophysiology, 1969, 27, 627. (Abstract)

In the previous projects EEG changes under different conditions, but with open eyes, were examined. In contrast, the present examination compares the effects of comparable tasks on the alpha rhythm with the eyes open and closed. Eight healthy subjects had EEG tracings recorded by telemetry under conditions of rest and 5 different states of activity. Automatic analysis of the left temporo-occipital EEG activity showed the following findings: (1) with the eyes open, in contrast to closed eyes, signs of increased desynchronization were found, without exception; (2) the changes during mental activity showed a greater than chance tendency to reach a mid level between extreme synchronization and extreme desynchronization. With the eyes closed this mid level was arrived at by an increase in desynchronization; with open eyes by synchronization; (3) the increase in synchronization with open eyes would appear to be mainly independent of whether visual components were immediately involved.

- 1084 Simons, R. F., & Lang, P. J. Psychophysical judgment: Electro-cortical and heart rate correlates of accuracy and uncertainty. Biological Psychology, 1976, 4, 51-64.

The relationship between perceptual accuracy and physiological response amplitude was investigated in an auditory pitch discrimination experiment. Confidence ratings were obtained from all subjects following each trial. The stimulus set consisted of three tones of different frequencies spaced in a manner to provide both easy and difficult discriminations. Heart rate, EEG and vertical eye movement were recorded throughout the experiment. The results of the experiment indicated that the largest evoked cardiac rate response was elicited by the stimulus which produced the fewest errors in judgment; larger auditory evoked potentials, particularly the late positive component (P 300), were associated with the 'easy' stimulus; greater cortical negativity was associated with the difficult stimuli, eye activity was found to covary with judgmental accuracy; cortical slow wave activity was particularly sensitive to the confidence, or 'uncertainty' parameter. A 'decision tree' model was hypothesized to describe the processing mechanism involved in solving the discrimination problem.

- 1085 Simpson, H. M., & Hale, S. M. Pupillary changes during a decision-making task. Perceptual and Motor Skills, 1969, 29, 495-498.

The effects on pupil size of a simple decision-making task were examined. Ss were assigned to either an experimental group ($n = 7$) or a yoked control group ($n = 7$). Ss in the experimental group were given a 2-choice decision task and on each trial S was presented 2 alternative directions in which a lever could be moved. S had to decide the direction to move the lever and, subsequently, make the response. Ss in the control group received essentially the same task conditions except no decision was required, since S was told which direction to move the lever. Results showed significantly greater pupillary dilation during the decision period in the experimental group than in the control group and these findings were discussed in terms of cognitive load.

1086 Singleton, W. T., Fox, J. G., & Whitfield, D. (Eds.). Measurement of man at work: An appraisal of physiological and psychological criteria in man-machine systems. London: Taylor & Francis, 1971.

After extensive discussion it emerged that, following a general introduction, there should be three main sections called respectively, Man, Techniques and Applications. The 'Application' section was easiest to understand and define, its purpose being to consider methodologies and strategies which are in use in relation to real problems and to illustrate these by recent case-studies. The distinction between 'Man' and 'Techniques' is not an easy one, but it is important and is worthy of detailed explanation. The expertise of every technologist is twofold: there is some topic about which he claims to have extensive knowledge and there is a repertoire of specialist techniques relevant to this topic in which he is a skilled practitioner. In the case of ergonomics the topic is normal, healthy man functioning in relation to some rational purpose in a particular environment; the techniques are those concerned with the measurement of man or of man-machine performance. In a modern technological society at any time man usually has some relationship with a machine, e.g. an air conditioning unit, a vehicle, a machine-tool. Clearly man has many descriptors and there must be a wide range of relevant techniques. The descriptors can each be approached by a variety of techniques but also a technique may provide evidence relevant to a variety of descriptors. For example, 'arousal' is a descriptor, two relevant techniques are postural measurement and heart rate measurement. Postural measurement is a technique relevant to arousal and also to physical size. Heart rate measurement is a technique relevant to arousal and also to energy expenditure. In this sense 'Man' and 'Techniques' are two separate dimensions. The ergonomist is professionally interested in descriptors of man which are actually or potentially useful in relation to man-machine interaction. This was the topic of discussion in the 'Man' section, in particular current trends in measurement and assessment. The ergonomist is equally interested in data acquisition procedures about man at work-- this was the topic of discussion in the 'Techniques' section, in particular, recently developed techniques, their advantages and limitations. This sectional division seemed to provide a useful structure to the Symposium and it has been retained in this book.

1087 Sjoberg, H. Relations between heart rate, reaction speed, and subjective effort at different work loads on a bicycle ergometer. Journal of Human Ergology.

The hypothesis concerning an inverted-U relationship between activation and performance was examined by comparing the performance of 25 subjects on a choice-reaction task at five different work loads on a bicycle ergometer. Heart rate was used as an index of activation. The results were in full agreement with the hypothesis, performance being more efficient at a medium activation level than at high and low levels.

- 1088 Skinner, P., & Antinoro, F. The effects of signal parameters on AER. Paper presented at the meeting of the IX International (World) Congress of Oto-Rhino-Laryngology, Mexico City, August 1969.

Three experiments were conducted using summing computer technique to study the effects of signal duration, rise time, and frequency on evoked auditory responses of adult subjects. The first experiment concerned the effects of signal duration. An additional objective of this experiment was to determine whether signal durations up to 150 msec would reflect temporal summation through amplitude and latency changes in the wave form of evoked potentials.

In this experiment 1000 Hz tones were presented at near threshold levels to maximize the probability of observing possible effects of temporal summation. No consistent trend was observed in the evoked responses with increments in signal duration. In the second experiment different rise times with 1000 Hz stimuli were presented at four sensation levels. A definite trend of increased peak amplitude in the potentials occurred as signal rise time was decreased. The third experiment was conducted to study the effects of signal frequencies from 250 to 8000 Hz on the evoked cortical potentials. The frequencies were studied at two intensities by sensation level and by equal loudness balance. A consistent decrease in the peak-to-peak amplitude was observed under both conditions as the frequency was increased.

- 1089 Smith, A. A., Malmö, R. B., & Shagass, C. An electromyographic study of listening and talking. Canadian Journal of Psychology, 1954, 8, 219-227.

Twenty-two psychiatric patients and 11 normal controls listened to a faulty sound recording. They were later asked to tell what they remembered of the record, and to report on their feelings while listening. EMGs from five muscle groups were recorded continuously throughout the experiment. Results were:

1. During listening, rising and falling gradients of tension were observed in speech muscles, and in extensor muscles of both arms.
2. All muscles recorded from showed significant increases in tension with talking.
3. Differences between patients and controls were seen only in speech muscles, and then chiefly during questioning about feelings.

The EMG gradients obtained in the present study were considered in relation to other such gradients observed in various kinds of performance on mental and motor tasks. The hypothesis was suggested that EMG gradients of this kind are related to phenomena of attention.

1090 Smith, D. B. D. Some interrelations between the contingent negative variation and the evoked potential. Psychophysiology, 1976, 13, 399-404.

The purpose of this study was to compare the evoked potential (EP) to the "imperative stimulus" (S₂) in the contingent negative variation (CNV) paradigm with the EP to a comparable stimulus not associated with a CNV. Twelve subjects performed a task that required reporting an occasional change in frequency of a tone. In one condition each change was paired with a warning flash, thus generating a CNV. In another condition tone changes were only occasionally preceded by a flash and no CNV was observed. Three differences were noted in the vertex EP associated with a CNV: 1) all components after approximately 60 msec were shifted in a more positive direction, 2) negative components N1 and N2 were shorter in latency, and 3) negative components N1, N2, and N3 were attenuated in amplitude. Possible interpretations of these results are discussed. Conclusions are drawn concerning the methodological and theoretical importance of this interaction between the CNV and EP.

1091 Smith, D. B. D., Donchin, E., Cohen, L., & Starr, A. Auditory averaged evoked potentials in man during selective binaural listening. Electroencephalography and Clinical Neurophysiology, 1970, 28, 146-152.

Average evoked potentials (AEPs) to clicks were obtained while a subject performed a selective listening task: the stimuli consisted of a series of numbers, letters and clicks, with separate series presented to each ear. Subjects were instructed to attend to one or the other ear and at different times to report the letters or clicks. The results show enhancement of a late positive component of the click AEP when clicks, but not when letters were reported. No differences in the AEP were found for those clicks presented in the attended ear as compared to those in the rejected (non-attended) ear.

1092 Smithline, H. Effect of signal rate and induced muscle tension on physiological responses and vigilance performance (Doctoral dissertation, New York University, School of Engineering and Science, 1970). Dissertation Abstracts International, 1971, 32, 312B-313B. (University Microfilms No. 71-18, 537)

Three experiments were performed to study the effect of intersignal interval (ISI), and induced muscle tension (IMT) on physiological measures and vigilance performance. The physiological measures examined were palmar skin conductance (PSC), heart rate (HR), and muscle action potential (MAP). Vigilance performance was measured in terms of reaction time (RT) to random visual signals presented in 20 minute experimental sessions. Each subject was studied in three separate sessions permitting the effect of session number also to be evaluated.

The primary purpose of the first experiment was to determine the effects of different ISIs on the relationship between RT and PSC. At ISIs of one to two minutes, it was found that shorter ISIs accompanied higher PSC levels and there were weak indications that shorter ISI yielded faster RTs. It was also observed that PSC levels declined in successive sessions as did RT levels.

The second experiment investigated the effect of manipulating activation level by inducing different levels of muscle tension while repeating Experiment 1 with a single ISI. Results indicated that higher levels of IMT induced higher PSC levels and faster RTs. In successive sessions PSC declined as in the first experiment, but the RT decrement was strongly mitigated by the IMT task.

For the third experiment the differences between three physiological measures were examined at a particular level of ISI and IMT. The three physiological measures were PSC, MAP, and HR. Some evidence was found to indicate that the autonomic and somatic systems are in step when compared at intervals separated more than a day, as well as in their phasic responses. However, action of the two systems were sometimes positively and sometimes negatively correlated over the duration of the 20 minute experimental sessions. These observations were taken to indicate the presence of a "periodic" arousal system which is slower acting than the tonic.

1003 Snider, I. J., & Bregman, A. S. The effect of GSR confirmed perception of bisensory input on immediate verbal memory. Psychophysiology, 1970, 7, 169-177.

Following adaptation, Ss learned visually presented paired associate (PA) word lists, while "distracting" verbal material was read aloud to them. Skin resistance was recorded. Ss who received auditory "interference" containing words present in the PA task made fewer errors than controls. An objective scoring method showed that GSR peaks following the onset of relevant words in the "interference" were more frequent than those following control words, confirming Ss' verbal reports of perception of and attention to relevant stimuli. The improved learning could not be accounted for by changes in the tonic level of skin resistance, but seemed to be a direct result of the bimodal input.

1004 Snook, S. H., & Dolliver, J. J. Driver fatigue: A study of two types of countermeasures. Proceedings of the 6th Congress of the International Ergonomics Association, 1976, 304-311.

This study investigated the effectiveness of auditory stimulation and performance feedback as fatigue countermeasures. Two types of auditory stimulation were used: (1) specially programmed music and (2) recordings of current news events. Two types of performance feedback came from (1) lateral position tracking and (2) speed tracking. It was hypothesized that each of the four countermeasures would significantly improve driver performance by reducing driver fatigue. Ten subjects were required to complete a series of three hour test sessions driving an automobile simulator. Each subject completed six control sessions without any of the countermeasures, followed by six experimental sessions utilizing one of the four countermeasures. Some subjects continued on with additional groups of six experimental sessions, each group with a different countermeasure. Dependent variables included lateral position error, speed variation, steering reversals, heart rate, and subjective fatigue. The results show that lateral position feedback was the only countermeasure that resulted in a consistent and significant improvement in driver performance. The results also suggest that early indications of speed variation and steering reversals are possible predictors of one's susceptibility to fatigue and poor performance during long distance driving, although further research is necessary.

- 1095 Solley, C. M., & Thetford, P. E. Skin potential responses and the span of attention. Psychophysiology, 1967, 3, 397-402.

Experiment I tested whether an alerting signal would increase the span of visual attention. Female Ss (16) were presented an array of letters exposed for 2 sec by a tachistoscope. Half of the Ss had a series of trials with a loud tone contiguous with the tachistoscope, followed by a series of trials with tachistoscope only. The remaining Ss received a reverse procedure--half the trials with no tone initially, followed by tone. The group receiving only tachistoscope followed by a series of tachistoscope plus tone trials showed a significant improvement in the number of letters correctly reported. Experiment II repeated the above with skin potential (SP) recording throughout the session to test that the tone would generate a momentary state of arousal (an orienting response) and an increase in the span of attention. Tone significantly produced larger positive SP amplitudes and more diphasic SP responses, and increased the number of letters correctly reported. All differences disappeared during the second trial series.

- 1096 Soskis, D. A., & Shagass, C. Evoked potential tests of augmenting-reducing. Psychophysiology, 1974, 11, 175-190.

Two evoked potential tests of augmenting-reducing, using flash and sine wave modulated light stimuli, were administered to 23 normal Ss to determine: a) generalizability between tests; b) short-term reliability; c) influence of electrooculographic (EOG) activity; d) relationships between perceptual discrimination of stimuli and evoked response measurements; e) correlation between evoked responses, extraversion and neuroticism (Eysenck Personality Inventory). Four months later 11 Ss were retested before and after pilocarpine fixation of the pupil in miosis, to assess long-term reliability and pupillary factors. Although mean amplitudes of sine and flash responses were significantly positively correlated, correlations between linear slope measures of their intensity-response functions were low. Both short- and long-term reliability were high for mean amplitudes, but relatively low for most slope measures. Ocular factors, as reflected in EOG and changes with pupillary miosis, appeared to exert relatively little influence on the evoked potential measures of augmenting-reducing. Subjective perceptual discrimination performance was not correlated with evoked potential measures. Extraversion was correlated with some evoked response augmenting indicators; neuroticism yielded inconsistent results. Generally, results varied with lead placement.

- 1097 Soutendam, J. Instruments and methodology for the assessment of physiological cost of performance in stressful continuous operations--the air traffic services tower environment. In K. E. Klein (Ed.), Methods to assess workload. AGARD Conference Preprint, No. 216, 1977. (Available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.)

A total of 39 females and males were used as subjects in a study designed to test the general validity and utility of methods and instruments of potential use in the determination of the physiological cost of work performance in stressful environments.

A second goal of the study was to attempt a preliminary test of the hypothesis that a form of employment (Air Traffic Services) traditionally considered stressful, was significantly different from general forms of employment traditionally considered less stressful. To test this hypothesis 23 people employed as air traffic control tower personnel were slated as the Experimental group and 16 subjects employed in an operationally oriented research facility served as the Control group.

Within the parameters of this research design, consistent statistical significance was established when the entire sample was recategorized on the basis of subjective sleep adequacy assessment rather than by job description. Further research is indicated with well defined physiological categorization measures to obtain more definitive answers concerning job stress and physiological cost and the methodology development necessary to support general research efforts in this field.

1098 Spekreljse, H. Analysis of EEG responses in man evoked by sine wave modulated light. Hague, Netherlands: W. Junk, 1966.

Our study of the electrophysiology of the human visual system has led to very few correlations with the psychophysics of it. This emphasizes our incomplete knowledge at least about the way in which the information is processed, as represented in the cortical responses. Nevertheless, the pathways involved in the perception and in evoking the responses must have sections in common.

It seems desirable to devise experiments especially directed to study this problem; the experiments described with the "chessboard" fields may provide a first step to this end. Even without this knowledge, however, a number of features of the electrophysiological system in itself seem well enough established and consistent to make the use of the obtained results in clinical ophthalmological and neurological research profitable.

1099 Spence, D. P., & Lugo, M. Cardiac change as an index of attention. Journal of Abnormal Psychology, 1973, 81, 289-295.

Conducted a study with undergraduates in which 7 experimental Ss clinically evaluated segments of a therapy protocol on the basis of specific verbal cues, and 9 controls made the same evaluation with no awareness of the clues. All Ss were monitored for heart rate while listening to the protocol and while making their judgments. All Ss showed lower and less variable heart rate during periods when they were listening to the clinical segments than during periods when they were making a clinical decision. The experimental group showed greater awareness of the verbal clues, but presence of clue was not associated with change in either mean or variability of heart rate.

1100 Spence, D. P., Lugo, M., & Youdin, R. Cardiac change as a function of attention to and awareness of continuous verbal test. Science, 1972, 176, 1344-1346.

A 17-minute passage taken from a patient's talking in a psychoanalytic interview was played to 40 subjects, including trained therapists, therapists in training, and inexperienced undergraduates. Subjects were alerted to the organizing theme (termination of the patient's treatment) and asked to attend to direct and indirect references to this theme. Tonic heart rate, averaged over 30 second periods, was lower when clues were present on the tape than during control periods when clues were not present. Profiles of phasic heart rate were drawn for 11-second periods that overlapped the end of each clue and control passage. Profiles associated with clues were significantly lower than profiles for control passages; profiles for recalled and recognized clues showed a wave form distinct from that of profiles associated with unrecognized clues.

- 1101 Spence, D. P., Lugo, M., & Youdin, R. Cardiac correlates of cognitive processing. Psychosomatic Medicine, 1974, 36, 420-437.

A 17 minute passage taken from a simulated psychoanalytic interview was played to a sample of trained therapists, therapists in training and inexperienced undergraduates who were alerted to the organizing theme (of termination of treatment) and asked to attend to direct and indirect references to this theme. Tonic heart rate, averaged over 30 second periods, was lower when clues were present than during control periods when clues were not present. Phasic heart rate (11 second profiles) in the vicinity of each clue was significantly lower than profiles surrounding control passages. Profiles surrounding recalled clues were significantly lower than profiles surrounding control clues. Profiles surrounding more relevant clues were significantly lower than profiles surrounding control clues whether or not the clue was recalled later. The findings suggest that decrease in mean heart rate can be used to mark the appearance of a significant stimulus even in cases where it does not appear in later recall; thus an on-line heart rate (HR) decrease may be a more sensitive index of stimulus processing than a later verbal report. Correlations were also found between HR change and clinical experience and between awareness of termination clues and clinical orientation.

- 1102 Spinks, J. A., & Siddle, D. A. T. Effects of stimulus information and stimulus duration on amplitude and habituation of the electrodermal orienting response. Biological Psychology, 1976, 4, 29-39.

This study was designed to investigate the effects of stimulus information and stimulus duration on the skin conductance response (SCR) component of the orienting response (OR). Three levels of stimulus information were combined with two levels of stimulus duration in a 3 X 2 independent groups factorial design (N = 90). On the basis of Sokolov's (1966) theory, it was hypothesized that: (a) high information stimuli would elicit larger initial SCRs than would stimuli of low information, (b) high-information stimuli would evoke more SCRs throughout a habituation series than would low-information stimuli, and (c) high-information stimuli would require more presentations to reach a habituation criterion than would stimuli of low information. It was also hypothesized that (d) long-duration stimuli would require fewer presentations to reach a habituation criterion and result in a faster rate of habituation than would stimuli of short duration. The stimuli consisted of black and white chequered patterns containing 12, 26 or 60 bits of information. Stimulus duration was either 0.5 or 4.5 sec, and each subject received 20 presentations at randomly ordered intervals of 20, 25, 30 and 35 sec. The results provided support for hypotheses (b), (c), and (d), but not for hypothesis (a). These results support the view that OR habituation can be conceptualized as a process of information extraction.

- 1103 Spong, P. Cortical evoked responses and attention in man (Doctoral dissertation, University of California, Los Angeles, 1966). Dissertation Abstracts, 1967, 27, 4150B. (University Microfilms No. 67-6512)

Major results of these experiments were: 1) Response magnitude was enhanced by both general and selective attentiveness. However, effects of general alerting outweighed effects of selective attentiveness. 2) Amplitude of somatosensory average cortical evoked response (ACER) component I was inversely related to attentive set in Experiment I, but was highly variable in Experiments II and III. In Experiment IV, however, comparisons between conditions indicated that both components I and II of somatosensory responses were consistently higher in amplitude under conditions of low general alertness. 3) Peak latency tended to decrease when component amplitude increased with attentiveness, but latency data were highly variable

Conclusions reached were: 1) Cortical evoked response amplitude varies with both general and selective attentiveness, but is more sensitively related to the former. 2) Analyses of evoked responses in terms of components and peaks are of assistance in the determination of effects of attentiveness on evoked responses, but latency measures are less useful than amplitude measures. 3) The amplitude of long-latency ACER components is positively related to level of attentiveness; the "primary" component, however, at least for somatosensory ACERs, may be negatively related to level of attentiveness.

- 1104 Spong, P., Haider, M., & Lindsley, D. B. Average evoked potentials during fluctuation of attention in humans. Electroencephalography and Clinical Neurophysiology, 1964, 17, 714-715. (Abstract)

In each of 15 experiments (3 subjects, 5 sessions each) amplitude of the evoked responses to missed signals was lower than to detected signals. The relation between reduced amplitude and inattention held regardless of whether or not the missed signals occurred early or late in the task. Less pronounced reductions in amplitude of evoked potentials were associated with long response times to detected signals which suggested diminished attention.

Reduced attention, as measured objectively by results, was paralleled by corresponding reductions in amplitude of the visually evoked potentials.

- 1105 Spong, P., Haider, M., & Lindsley, D. B. Selective attention and cortical evoked potentials. Electroencephalography and Clinical Neurophysiology, 1965, 18, 523. (Abstract)

Temporal and occipital evoked potentials to both click and flash stimuli were compared under attentive and non-attentive states. Additionally, the effects on these evoked potentials of the three different methods of manipulating selective attentiveness were investigated. Differential effects of selective attention on cortical evoked potentials were demonstrated.

- 1106 Spong, P., Haider, M., & Lindsley, D. B. Selective attentiveness and cortical evoked responses to visual and auditory stimuli. Science, 1965, 148, 395-397.

Cortical evoked responses to flashes and clicks were recorded from human subjects performing visual or auditory tasks under three conditions of selective attentiveness. The subjects were required to attend to the flashes and to ignore alternating clicks, or vice versa. Responses to flashes recorded from the occipital area were larger when attention was directed toward visual stimuli, and responses to click stimuli recorded from the temporal area were larger when attention was directed toward auditory stimuli.

- 1107 Spong, P., & Lindsley, D. B. Cortical evoked responses and attentiveness in man: Differential effects of selective attentiveness and general alertness level. Electroencephalography and Clinical Neurophysiology, 1968, 24, 396-397. (Abstract)

(1) Average cortical evoked response (ACER) magnitude varies with both general and selective attentiveness, but is more sensitively related to the former. (2) Amplitude of long latency ACER components is positively related to attentiveness level; the "primary" component, however, at least for somato-sensory ACERs, may be negatively related to attentiveness level. (3) ACER analyses in terms of components and peaks are useful in determining effects of attentiveness on evoked responses, but latency measures are less useful than amplitude measures. (4) Careful analyses of human ACERs may enable interpretation of them in terms of brain mechanisms controlling behavior.

- 1108 Squires, K. C., & Donchin, E. Beyond averaging: The use of discriminant functions to recognize event related potentials elicited by single auditory stimuli. Electroencephalography and Clinical Neurophysiology, 1976, 41, 449-459.

A test of the stepwise discriminant analysis (SWDA) procedure for assessing single-trial event related potentials (ERPs) is presented. Discriminant functions (DFs) were built from a data base composed of single-trial ERPs from sixteen subjects who were presented trains of loud and soft tones. Loud tones occurred randomly on 10% of the trials. Subjects either counted the rare-- loud stimuli or solved a hidden-word puzzle. Various DFs at three electrode sites (Fz, Cz and Pz) were obtained to assess the feasibility of performing pairwise discriminations between the various combinations of events which are defined by this procedure. For the pair of events which yielded the most striking differences between their average ERP waveforms it was possible to classify correctly, an average of 84% of the events using information from one electrode site, and 89% of the events if information from multiple electrode sites was used. A "subject-independent" DF was developed from these data and applied to data obtained from seven new subjects. This subject-independent function proved to be sufficiently generalized to classify correctly 81% of the trials. The nature of classification errors by this procedure is discussed.

- 1109 Squires, K. C., Hillyard, S. A., & Lindsay, P. H. Cortical potentials evoked by confirming and disconfirming feedback following an auditory discrimination. Perception and Psychophysics, 1973, 13, 25-31.

Vertex potentials elicited by visual feedback signals following an auditory intensity discrimination have been studied with eight Ss. Feedback signals which confirmed the prior sensory decision elicited small P3s, while disconfirming feedback elicited P3s that were larger. On the average, the latency of P3 was also found to increase with increasing disparity between the judgment and the feedback information. These effects were part of an overall dichotomy in waveshape following confirming vs disconfirming feedback. These findings are incorporated in a general model of the role of P3 in perceptual decision making.

- 1110 Squires, K. C., Petuchowski, S., Wickens, C., & Donchin, E. Sequential effects on event-related potentials: A comparison of auditory and visual modalities. Psychophysiology, 1977, 14, 96. (Abstract)

Subjects react to a random sequence of binary events as if the series were constrained by sequential rules. The reaction to an auditory stimulus on trial n of a sequence is influenced by stimuli presented as far back as trial $n-5$, as indicated both by choice reaction time and event-related potential (ERP) measures.

Squires, Wickens, Squires, and Donchin (in press) proposed a model that accounts for these data in terms of "expectancy." Expectancy fluctuates from trial to trial as a function of a decaying short-term memory for preceding events, incidental patterns formed by these events, and the a priori probability of the stimuli.

The present experiment was designed to determine whether the model developed for auditory sequences applies to the ERPs associated with visual sequences and whether the parameters of the model were the same for both modalities.

Seven subjects (3 females, 4 males) were presented with series of auditory and series of visual stimuli. In the auditory series, stimuli were either 1000 Hz or 1500 Hz tones; in the visual series, either blue or orange flashes were used. In each series, the two stimuli appeared with equal probability. Subjects counted the high tone in the auditory series and the blue flash in the visual series. Each subject was presented with at least 5 200-stimuli series in each modality. EEG was recorded (monopolarly) from Pz, Cz, and Fz.

Strong sequential effects on the ERP waveform were found in both modalities, confirming the general validity of the reported relationship between ERP amplitude and the structure of the stimulus sequence. The expectancy model holds for both visual and auditory sequences. Certain differences between the modalities can be accounted for by variations in the duration of echoic and iconic memory.

- 1111 Squires, K. C., V. ickens, C., Squires, N. K., & Donchin, E. The effect of stimulus sequence on the waveform of the cortical event-related potential. Science, 1976, 193, 1142-1146.

The waveform of the cortical event-related potential is extremely sensitive to variations in the sequence of stimuli preceding the eliciting event. The waveform changes were manifested primarily in the amplitudes of the negative component of the potential that peaked at 200 milliseconds, the positive component that peaked at 300 milliseconds, and the slow-wave components. A quantitative model was developed relating the waveform changes to changes in event expectancy. Expectancy is assumed to depend on a decaying memory for events within the prior sequence, the specific structure of the sequence, and the global probability of event occurrence. For stimuli relevant to the task, the less expected the stimulus the larger the amplitudes of late components of the event-related potentials.

- 1112 Squires, N. K., Duncan-Johnson, C. C., Squires, K. C., & Donchin, E. Cross-modal sequential effects on the P300 component of the event-related potential. Psychophysiology, 1977, 14, 96. (Abstract)

Subjects react to a random sequence of binary events as if the series were constrained by sequential rules. The reaction to an auditory stimulus on trial n of a sequence is influenced by stimuli presented as far back as trial $n-5$, as indicated both by choice reaction time and event-related potential (ERP) measures. In a companion report (Squires, K. et al., this meeting), we show that these sequential effects operate in a similar manner for auditory and visual sequences. The present experiment is concerned with the degree to which these sequential dependencies are maintained when the subjects are presented with auditory-visual compounds.

Eleven subjects were presented with series of bisensory stimuli, each consisting of one tone (1000 or 1100 Hz) and one light flash (orange or blue). Three of the four auditory-visual compounds had a priori probabilities of .10; the fourth bisensory stimulus (1000 Hz tone -blue flash) was presented with a probability of .70. Subjects counted the three equi-probable compounds of rare stimuli.

The EEG was recorded from Pz, Cz, and Fz referred to linked mastoids.

Visual inspection of the average ERPs revealed that the P300 and Slow Wave components were inversely related to the a priori probability of the bisensory stimulus (i.e., double-rare stimuli elicited the largest amplitude components and double-frequent stimuli the smallest, with the rare-frequent combinations eliciting components of intermediate amplitude).

If the P300 component reflects modality-independent processing, it is predicted that intramodal and cross-modal sequential effects will be equivalent. The data appear to support this hypothesis. It seems, therefore, that subjects categorize the bisensory stimuli as "rare" or "frequent" across rather than within modalities.

1113 Stamm, J. S. On the relationship between reaction time to light and latency of blocking of the alpha rhythm. Electroencephalography and Clinical Neurophysiology, 1952, 4, 61-68.

1. Mean reaction times for the group of subjects decreased systematically from 0.408 sec under discrimination to 0.319 sec under the speed-b condition. Latencies, however, did not decrease effectively and varied only between 0.346 sec under passive to 0.327 sec under speed-b condition. The mean correlation coefficients between the two measures were approximately 0.3.

2. Under every reaction condition there were subjects who responded with longer latencies than reaction times, and under the speed-b condition an average of 43 per cent of the responses was in this manner.

3. Statistical evaluations of the data showed that the differences between the mean reaction times under any two conditions were significant, whereas the differences of latent times between the passive and any reaction condition were not significant.

4. It was concluded that reaction and latent times were measures of essentially independent systems.

1114 Starobinets, M. Kh. Postoyannye polarizatsionnye potentsialy golovnoy mozga cheloveka vo vremya bodrstvovaniya, narkoza i sna. [Steady polarization potentials of the human brain during the time of vigilance, narcosis, and sleep.] Zhurnal Vysshei Nervnoi Deyateli' nosti, 1967, 17, 338-344.

It has been shown by the compensation method of measuring steady polarization potentials of the human brain recorded from the skin surface of the frontal-temporal area that the orienting reflex is accompanied by a diminution of the electro-positive potential on the side of the head electrode.

The setting in of natural, barbiturate and hypnotic sleep is connected with the development of hyperpolarization of the human brain, while ether anaesthesia is attended with depolarization. Hyperpolarization of the brain in natural and barbiturate sleep is passive by its genesis and from G. N. Sorokhtin's standpoint is regarded as an electrophysiological expression of the atony of cortical centres.

1115 Steele, W. G., & Koons, P. B., Jr. Cardiac response to mental arithmetic under quiet and white noise distraction. Psychonomic Science, 1968, 11, 273-274.

Ss were 10 females and 5 males, 19-26 yr old. The cardiac response to the mental arithmetic task was cardiac acceleration. The increase during the distracting condition was significantly higher than the increase during the quiet condition. These results were predicted from Lacey's theoretical formulations.

- 1116 Steele, W. G., & Lewis, M. A longitudinal study of the cardiac response during a problem-solving task and its relationship to general cognitive function. Psychonomic Science, 1968, 11, 275-276.

It has been hypothesized that cardiac responsivity should vary as a function of the S's intended transaction with his environment. A developmental inquiry was instigated to determine the cardiac response to a mental arithmetic problem. Across age levels, Ss showed cardiac acceleration during problem solution. While there was no developmental pattern in the amount of acceleration, the results did indicate that the amount of cardiac acceleration was positively related to Ss' IQ.

- 1117 Steinhoff, W. D. Tagesrhythmische Schwankungen von Kreislauf, Atmung und Gasstoffwechsel Unter Fliegerischer Belastung. [Circadian rhythms of blood circulation, respiration and catabolism under stress in a flight simulator.] TRC Report No. T72-09710, 1972. [also abstracted in R and D Abstracts]

In order to determine the circadian rhythms of physiological standards under the stress of flying, the pulse rate, frequency of respiration, O₂ -inspiration and CO₂ -expiration have been investigated in a flight simulator with seventeen pilots of the GAF. The results showed an exact circadian rhythm with gradual ascent of the physiological activity during the morning hours until a maximum during the early morning. The nightly trough in performance, which once again is proven by our results, should be considered seriously in flight schedules of military and civilian aviation.

- 1118 Stennett, R. G. The relationship of performance level to level of arousal. Journal of Experimental Psychology, 1957, 54, 54-61.

A test of the hypothesis that an inverted-U relationship exists between the level of arousal and performance level was made by comparing the performance of 31 Ss on an auditory tracking task under different conditions of incentive. These conditions ranged widely from one in which S was under the impression that his scores were not even being recorded to one in which his score determined whether or not he avoided a 100-150-v shock and earned bonus money of from \$2.00 to \$5.00. When the effects of learning on performance scores were controlled and an interaction effect of the order of presentation of the experimental conditions had been partialled out, the data of this study gave strong support to the hypothesis. The hypothesis held regardless of whether palmar conductance level or the EMG response of any one of four different muscle groups was used as the criterion of arousal.

- 1116 Stephens, W. J., & Fenz, W. D. The effect of motivation on cardiac activity in a reaction time task under conditions of augmented feedback. Psychophysiology, 1971, 8, 264. (Abstract)

The relationship between cardiac activity and reaction time was investigated under two conditions of motivation; an additional variable, augmented heart rate feedback, was also studied.

Three groups, each containing 10 Ss, were instructed to press a key, as quickly as possible, following termination of a mild 10 sec tone: one group received augmented visual feedback of its heart rate throughout the experiment, a second group received false visual feedback, and a third group received no feedback at all. After 20 reaction time responses all Ss received new instructions: Immediately following each key-press response, they were shown, via an oscilloscope, their mean reaction time over the first 20 trials, as well as their reaction time on each new trial. To induce motivation Ss were told that they would receive 10 cents for every trial in which they responded faster than the computed mean of the first 20 trials.

The results indicate that for all groups there was a highly reliable decrease in reaction time due to the motivating instructions. In considering the anticipatory 10 sec period, the heart rate data for the combined groups revealed that the facilitating effect on reaction time during motivation is related to the increased alerting or arousing effect of the "get ready" signal, rather than the level of arousal (heart rate) at the time of responding. Comparisons of the three groups indicated that only the true feedback group showed a significant effect due to motivation, namely an increase in cardiac acceleration to the "get ready" signal.

- 1120 Stern, J. A. Terminal OR's: Developmental considerations. Unpublished manuscript, undated. (Available from J. A. Stern, Washington University, Behavior Research Lab, 1420 Grattan Street, St. Louis, Mo., 63104)

Our results, to date, are thus generally in accord with our hypothesized meaning of the terminal and onset OR. Namely that 1) the onset OR is affected by stimulus complexity and predictability, as well as response complexity, and 2) the terminal OR is affected by stimulus duration. Developmentally we see that with simple stimuli of relatively long duration, age dependent differences in habituation rate of the terminal OR occur and no differences in onset OR habituation are manifested. Making the stimulus somewhat more complex and longer we can obtain age related differences in both the onset and terminal OR.

Speed of habituation of the terminal OR is, in our opinion, affected by such factors as "attention span" and ability to conceptualize time, both being factors which develop as a function of age, and we believe life experiences-- though a number of papers I've heard in the last two days cast aspersions on this latter variable. We are hoping to continue our investigations of developmental factors related to both onset as well as terminal OR's when funds again become available for this research.

1121 Stern, J. A. Visual perception and behavior. In The second annual symposium for visual perception. Symposium sponsored by the University of Missouri, St. Louis, 1969.

Our studies compare the visual search activity of skilled helicopter pilots and unskilled pilots, using polygraph writeouts. The results clearly indicate that in the horizontal plane skilled pilots do considerably more visual searching than is true of unskilled pilots. We also found that in both skilled and unskilled pilots, there are significant decrements in visual search over time.

What was even more startling and perhaps more frightening was a phenomenon referred to as "time-out." Time-out activity is defined by us as durations of time when the eyes are seen not to move in either the horizontal or vertical plane, nor do any blinks occur during this period of time. Our suspicion is that when we see this type of activity, the subject is staring and probably not seeing anything. This type of activity also increases as a function of time on task. In some cases we have seen durations of time-out activity lasting 50-60 seconds. This is frightening in a fast moving helicopter. We suspect that the same is true of automobile driving and we plan to extend this research into that area.

1122 Stern, J. A. The effect of fatigue on visual search activity -- final report. St. Louis, Missouri: Washington University, Behavior Research Lab, July 1972. (NTIS No. AD 750097)

This report reviews our work on a) the development of recording techniques for obtaining outputs from the manipulanda of helicopters (UH-1D) and automobiles, as well as techniques for processing such data. The majority of the report deals with the recording and utilization of measures of visual search activity for the assessment of pilot performance as a function of such variables as level of training, time on task, and sleep deprivation. During the contract period, we developed the necessary hardware for electrooculographic recording of visual search activity, and computer techniques for abstracting relevant information from these records. Two published studies utilizing these procedures are part of this report.

The report further details some further development of the application of our analytic programs to the evaluation of reading activity.

- 1123 Stern, J. A., Beideman, L., & Chen, S. C. Effect of alcohol on visual search and motor performance during complex task performance. In M. Horvath (Ed.), Adverse effects of environmental chemicals and psychotropic drugs: Neurophysiological and behavioral tests (Vol 2). New York: Elsevier Scientific Publishing Co., 1976.

Electrooculographically recorded eye movements and outputs from wheel, accelerator, brake and turn signal indicator were obtained while subjects were driving an automobile simulator under both sober and "inebriated" conditions (average BAC levels of 73 mgm%). Significant changes in aspects of visual search, eye blink and motor output were obtained both as a function of state (sober vs inebriated) and time-on-task ("fatigue" effects). Data reduction utilized a small digital computer (PDP-12) and examples of types of analysis performed are presented. Consistent, across subjects, results were obtained for the visual search parameters with respect to alcohol effects. The patterns of decrements in performance as a function of alcohol were more individualized. On the latter measures, in general, subjects performed with shorter response latencies when inebriated but demonstrated markedly impaired performance as measured by such variables as slope of response, overshoot in response, and vacillatory compensatory reactions. On the visual search measures alcohol effects were manifested by decrements in incidence of saccadic eye movements (longer fixation pauses), more rapid development of "fatigue" effects, alteration in patterning of visual search activity, and significant changes in blink patterns.

- 1124 Stern, J. A., & Bynum, J. A. Analysis of visual search activity in skilled and novice helicopter pilots. Aerospace Medicine, 1970, 41, 300-305.

Eye movements in both the horizontal as well as vertical plane and eye blinks were recorded in 13 skilled and 13 unskilled pilots while flying the UH-1D helicopter during a cross-country flight of approximately 50 minutes duration. Saccadic eye movements in both the horizontal and vertical plane were evaluated. The results demonstrate that skilled pilots engage in significantly more visual search activity in the horizontal plane than is true of novice pilots. Both skilled and unskilled pilots demonstrate changes in visual search activity as a function of time on task. These changes include: a decrease of searching in the horizontal plane; a decrease in searching in the vertical plane; an increase in the amount of time not engaged in search activity per unit time; and a decrease in blink rate. These results are interpreted as suggesting a decrease in visual search activity as a function of time-on-task.

- 1125 Stern, R. M. Electrophysiological effects of the interaction between task demands and sensory input. Canadian Journal of Psychology, 1964, 18, 311-320.

It was the purpose of this study to investigate the effects of reduced sensory input on two task conditions. The effects were measured in terms of the electrophysiological activity of the autonomic nervous system and the skeletal muscle system. A Vigil group reported the "movements" of an autokinetic light; a Rest group simply relaxed. The autonomic indices revealed significantly higher activity for the Vigil Group, thus supporting Duffy and Malmo's hypothesis concerning the importance of task demands in determining level of physiological activity.

- 1126 Stern, R. M. Performance and physiological arousal during two vigilance tasks varying in signal presentation rate. Perceptual and Motor Skills, 1966, 23, 691-700.

The purpose of this study was to compare vigilance performance and level of arousal of two groups of Ss differing in the signal presentation rate they received. It was hypothesized that a group receiving relatively infrequent signals would be over-aroused and would perform at a lower level primarily because they would be responding to irrelevant stimuli. Basal skin resistance and muscle potentials indicated that, as hypothesized, the infrequent Ss were more highly aroused than the frequent Ss. Performance data indicated that the infrequent group made a smaller percentage of correct detections and a much greater number of false alarms than the frequent group.

- 1127 Stern, R. M. Reaction time and heart rate between the GET SET and GO of simulated races. Psychophysiology, 1976, 13, 149-154.

The results of three experiments are reported in which simulated race situations, i.e., GET SET-5 sec-GO, were used to examine the anticipatory HR response and RT. The first study involved sprinting up a flight of stairs and the second and third a bicycle sprint. The typical pattern of phasic HR found was acceleration until 1 sec prior to GO and then deceleration. Tonic HR appeared to be a function of the degree of anticipated physical effort. Muscle potential, recorded in the first experiment, appeared to be related to HR. No systematic relationship was found between HR and RT.

- 1128 Storm, W. F. Vigilance, habituation, and the cortical evoked response (Doctoral dissertation, University of Missouri, Columbia, 1970). Dissertation Abstracts International, 1970, 31, 3036B-3037B. (University Microfilms No. 70-20, 820)

Based upon sensory habituation findings, a modification of the arousal hypothesis was proposed to explain and predict vigilance behavior. Two vigilance experiments were performed to test the capabilities of this arousal-habituation approach. In both experiments, 24 male subjects (12 assigned to each experiment) individually monitored a repetitively flashing light and were instructed to respond when flashes of reduced intensity (signals) occurred. Occipital and vertex evoked responses elicited by signal and non-signal stimuli were recorded and later averaged by computer for analysis. The amplitude of the averaged evoked response to non-signal stimuli served as indicants of the degree of neurophysiological arousal.

In Experiment I, subjects performed in four 40-minute sessions on successive days. The effects of manipulating periodicity of interstimulus intervals (regular vs. irregular) and signal rate (high vs. low) were investigated. Whereas subjects always performed in the same signal rate condition in each session, an ABBA design was employed to obtain repeated measures on the periodicity factor. In general, a negatively accelerated deterioration in detection performance within a session was accompanied by a parallel decrement in occipital evoked response amplitude. Vertex evoked response amplitude demonstrated no change within a session. The predicted effect of irregular stimulus presentation was not upheld.

In Experiment II, signal probability, and not the total amount of stimulation, proved to be the determining factor for the maintenance of vigilance performance and occipital evoked response amplitude. As predicted by the arousal-habituation hypothesis, detection performance and occipital amplitude deteriorated only when the ratio of signal stimuli to non-signal stimuli was relatively low. As in Experiment I, vertex amplitude failed to reflect changes in performance.

In summary, the arousal-habituation explanation of vigilance behavior was supported by the following findings: (a) if detection performance deteriorated within a vigil, it was accompanied by a decrement in the amplitude of the occipital evoked response; (b) detected signal stimuli elicited occipital evoked responses of increased amplitude, whereas missed signals did not; and (c) maintenance of detection performance and occipital response amplitude was a function of signal probability. Contradictory evidence resulted from the detrimental effect upon performance and evoked response amplitude of presenting stimuli at irregular interstimulus intervals.

- 1129 Strasser, H. Herzfrequenz-und Sinusarrhythmie-Messungen zur Frage der Objektivierung von Konzentration und Beanspruchung in Regelaufgaben. [Heart rate and sinusoidal arrhythmia in view of objectivating concentration and stress in control tasks.] Paper presented at the 14th meeting of the committee "Anthropotechnik" of the Deutsche Gesellschaft für Luft- und Raumfahrt, Munich, November 1973. [Also abstracted in Scientific and Technical Aerospace Reports (Report No. DLR-Mitt 74-19).]

Mental effort during control tasks such as pursuit tracking tests was correlated with heart rate, low frequency arrhythmia, and high frequency sinus arrhythmia profiles monitored for several hours. Results show that pulse frequency and sinusoidal arrhythmia appear in a somewhat reciprocal relation. Sinus arrhythmia, though varying greatly among individuals, is a reliable parameter which provides supplementary information when test linked factors cease to show up in pulse frequency.

- 1130 Strasser, H. Physiological measures of workload - correlations between physiological parameters and operational performance. In K. E. Klein (Ed.), Methods to assess workload. AGARD Conference Preprint, No. 216, 1977. (Available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.)

Stress defined as input load of man at work may be assessed by means of operational measures and time studies, but strain as the individual output cannot essentially be quantified without also considering physiological data. Variability of some physiological parameters, mostly used in the field of workload studies, will be described and their efficacy discussed for practical applications in field studies. Methodical problems and improvements to counterbalance these problems will be shown, too. Problems involved in interpretations of operational and physiological data, will be dealt with.

Very often in experimental research on stress and strain, correlations between operational, physiological and subjective rating parameters of workload are expected. By means of data from experimental laboratory studies with simultaneously registered physiological and operational performance measures, it will be demonstrated when correlations can be found and when not.

The influence of different hypoxic gas mixtures on pursuit tracking and on some physiological parameters has been studied. From the results the following conclusions can be made: Already in relatively mild hypoxia physiological changes are present, but normally were concealed by reactions due to prolonged test time. In spite of statistically significant physiological effects, no noticeable deteriorations of performance in tracking could be measured in hypoxia down to a hypoxic gas mixture of only 13% O₂ in inspired air. Not until before 11% O₂ significant and mentionable impairments of tracking performance were found.

The same, shown for hypoxia, is true of noise. Decreased performance in noise could not be found, but an increased level of heart rate indicated the stress.

Hence physiological indicators definitely react already in a low workload in order to bring in action reserves of energy, which will guarantee a normal performance. Often operational measures alone would fail to indicate the strain of the human operator. Only in high workload, correlations between performance and physiological measures can be expected.

1131 Straumanis, J. J., Jr., Shagass, C., & Overton, D. A. Problems associated with application of the contingent negative variation to psychiatric research. The Journal of Nervous and Mental Disease, 1969, 148, 170-179.

As a first step in applying Walter's contingent negative variation (CNV) in comparative studies of psychiatric patients, data were obtained concerning the issues of contamination by activity arising in the orbit and of individual variability between different test paradigms. Subjects were 20 college students and 10 psychiatric inpatients. Looking only at the conventional CNV recording leads (vertex-mastoid), a significant CNV was obtained in two experimental paradigms. However, analysis of the spatial distribution of the potential strongly suggested that much of the recorded vertex-mastoid negative shift can be accounted for by activity associated with eye movement. The distribution of CNV closely paralleled the distribution of vertical eye movement potentials. Results in patients and nonpatients were similar. The vertex-mastoid lead placement appears to be a poor one for recording relatively uncontaminated CNV; vertex-temporal derivation appears promising, although a smaller negative shift was recorded there.

CNV measurements of the same subjects obtained under two experimental conditions were poorly correlated with each other, suggesting that the CNV responsiveness under any one condition does not characterize the individual. It was concluded that application of CNV recording to psychiatric research presents serious methodological and interpretive difficulties.

1132 Stroh, C. M. Vigilance: The problem of sustained attention. New York: Pergamon, 1971.

This book reviews the theoretical and empirical data pertaining to vigilance. The following topics are discussed:

1. Factors influencing vigilance performance
2. Physiological correlates of vigilance performance
3. Theories of vigilance performance
4. Related theories and phenomena
5. Conclusions and discussion.

- 1133** Stroh, C. M. The influence of personality and age on the relationship between vigilance performance and arousal level. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

Twenty-four male volunteer subjects took part in a one-hour visual vigilance task in which they were required to detect flashes of unusual intensity in a regular series of flashes. EEG alpha-incidence, log skin-conductance, and pulse-rate, recorded in the ten-second period prior to each of the eighteen signal presentations, did not distinguish between signals missed and signals detected. Analysis of individual differences in EEG change revealed significant differences due to neuroticism and age. Older, less neurotic subjects improved their performance when their arousal level is raised; younger, more neurotic individuals evidence a performance decrement when arousal level is increased. Our hypothesis concerning the effects of neuroticism and/or extraversion on the vigilance - arousal relationship was supported.

- 1134** Suenaga, K., Goto, K., & Suenaga, H. Study of EEG of bus drivers while driving and at rest. Kurume Medical Journal, 1967, 14, 43-48.

EEG before, during and after driving was surveyed in order to investigate the method for determining the suitability of motorists. Subjects were divided into a group with accidents and that without accidents, and the patterns of appearance of alpha waves at rest in eye-closed state, at rest in eye-opened state and in the time of driving were comparatively studied.

1. Low frequency alpha waves were often observed in individuals with accidents, in a resting eye-closed state, but were less in those without accidents.

2. High rate of alpha waves in a resting eye-opened state was frequent in a group with accidents, but less in a group without accidents.

3. Most cases with dominant alpha waves during motor driving belong to a group with accidents while few of them to a group without accidents.

- 1135** Sugarman, R. C., & Cozad, C. P. Road tests of alertness variables (ZM-5019-B-1). Buffalo, New York: Calspan Corp. November 1972. (NTIS No. PB-215 450)

The study consisted of an on-road validation of a previous study of factors affecting driver alertness which used a driving simulator to investigate the effects of driving time, acoustic noise, and task complexity on driver performance. The on-road study closely duplicated the low-event, long-duration driving environment. In general, the findings of the simulator study were verified, with exceptions attributable to the inherent lack of experimental control in the field-test situations. It was confirmed that lateral road position error significantly increased as a function of time, as also does the occurrence of the alpha rhythm in the electroencephalogram (EEG). The number of small (2^0) steering wheel reversals also tended to decrease as time progressed. Although not demonstrated in the simulator study, the use of an automatic speed controller was found to foster decreases in alertness, as evidenced by changes in heart rate and the theta EEG component. Loud, continuous noise acted as a stressful stimulus - physiological measures indicated high arousal, while a performance measure showed higher error scores than shown at lower noise levels. Many of the measures were found to supplement each other, leading to a recommendation for a multiple regression analysis to develop an advanced index of driver alertness.

1136 Surwillo, W. W. Psychological factors in muscle-action potentials: EMG gradients. Journal of Experimental Psychology, 1956, 52, 263-272.

Previous studies have demonstrated that electrical activity in certain muscles increases progressively from the beginning to the end of a task. These rises have been termed electromyographic (EMG) gradients; and there is evidence which suggests that their slope is related to level of motivation.

The main purpose of the present study was to test the hypothesis that slope of EMG gradients can be increased by raising the incentives in a task. Other related factors investigated were difficulty and goal structuring. A tracking task was administered as compensatory pursuit (Task A) and following pursuit (Task B). Both required almost identical forces and patterns of muscular response; muscular activity was limited to nearly isometric contractions.

Sixteen college students performed Task A and Task B in balanced order. Incentives were considerably higher in Task A, it was more difficult, and more strongly goal structured than Task B. EMGs from three of four muscles studied revealed steeper gradients for Task A. Control conditions showed that the increases could not be attributed to either variations in grip pressure or to muscular fatigue.

The study was repeated with 16 RCAF men. In this case, a third task with a higher incentive - doubly rewarded Task A - was introduced. Degree of muscular effort required in performance was also studied. Results indicated that incentive was the primary factor in raising the EMG gradient. Shape of gradients was invariant with the amount of muscular effort required for performance.

1137 Surwillo, W. W. Frequency of the 'alpha' rhythm, reaction time and age. Nature, 1961, 191, 823-824.

Thus, although data from only a small number of subjects were available, this investigation reveals the presence of a significant relationship between a person's average 'alpha' period and average reaction time: the longer the 'alpha' period (slower 'alpha' rhythm), the slower the response. It also suggests that older subjects with longer reaction times have correspondingly lower 'alpha' frequencies in the interval between stimulus and response than younger subjects with shorter reaction times. While no causal relationship is implied by the correlations, the results nevertheless lead to the speculation that the 'alpha' cycle, or some multiple of it, may serve as the unit of time in the programming of the nervous system. This possible implication is sufficient to warrant verification of our findings and further study. We need to know, for example, what specific part is played by age in this relationship, and whether the relationship holds in individual subjects.

1138 Surwillo, W. W. The relation of simple response time to brain-wave frequency and the effects of age. Electroencephalography and Clinical Neurophysiology, 1963, 15, 105-114.

An experiment was performed to verify a previous finding of a positive correlation (0.81) between response time and period of the EEG. Details of this relationship, with reference to age and to a hypothesis concerning the function of the brain-wave cycle in simple behavior, were investigated.

Reaction times and average period of the EEG, recorded in the interval of time between stimulus and response, were determined for 100 subjects ranging in age from 28-99 years. The major results were:

1. The previous finding was confirmed. In the present study a correlation coefficient of 0.72 was obtained between average reaction time and the average period of the EEG.

2. Excluding age from this relationship through the use of partial correlation, scarcely altered this coefficient. Age as a factor in the observed correlation was, therefore, ruled out.

3. A highly significant positive correlation was obtained between age of the subjects and the average period of their brain waves.

4. A low but statistically significant positive correlation was found relating average reaction time and age. This positive coefficient vanished and became negative when brain-wave period was "partialled out". It was inferred, therefore, that EEG frequency is the central nervous system factor behind age-associated slowing in response time.

5. Evidence derived from data of each subject taken singly showed the presence of a positive correlation between brain-wave period and reaction time in individual subjects.

6. Taken as a whole, the data support the hypothesis that the brain-wave cycle is the basic unit of time in terms of which a response is programmed by the central nervous system.

1139 Surwillo, W. W. The relation of decision time to brain wave frequency and to age. Electroencephalography and Clinical Neurophysiology, 1964, 16, 510-514.

Fifty-four Ss ranging in age from 34-92 years were requested to decide between 2 alternatives to examine the relationship between decision time and EEG period plus decision time and age. Evidence was obtained to support the hypothesis that Ss with slow brain waves require longer to make decisions than do Ss with faster brain waves. Decision time was also related to age, but when EEG frequency was held constant this relationship completely vanished. EEG frequency was postulated as the factor behind the age associated drop in information capacity of the central nervous system.

- 1140 Surwillo, W. W. Some observations on the relation of response speed to frequency of photic stimulation under conditions of EEG synchronization. Electroencephalography and Clinical Neurophysiology, 1964, 17, 194-198.

The question of whether a person's reaction time can be increased and decreased merely by slowing down and speeding up the frequency of the brain's dominant rhythm was investigated.

From a total of 48 subjects who were examined, five were found whose EEGs could be synchronized to a flashing light over a wide frequency range while they were tested on a reaction task. Although response time and period of the photic stimulus proved to be positively correlated under conditions of EEG synchronization, the findings were only suggestive and could not be used as a basis for any generalization.

- 1141 Surwillo, W. W. The relation of autonomic activity to age differences in vigilance. Journal of Gerontology, 1966, 21, 257-260.

To test the hypothesis that differences in autonomic activity are associated with age differences in the rate at which vigilance deteriorates, heart rate, palmar skin temperature, and palmar skin potential were studied in a group of 33 young (Mn = 36.4 years) and 33 old (Mn = 74.3 years) males. Ss continuously monitored the discrete movements of a pointer for a period of one hour and pressed a response key whenever the pointer displayed a specific, irregular type of movement. In the final 45 minutes of the task, heart rate declined and skin potential increased progressively. The slopes of the regression lines that described these changes, however, did not differ significantly with age. Skin temperature, on the other hand, declined progressively with time in the young group but not in the old group, and the slopes in this case differed significantly. The latter result was consistent with the hypothesis that differences in autonomic activity are associated with the more rapid decline of vigilance in old than in young Ss.

- 1142 Surwillo, W. W. Time perception and the 'internal clock': Some observations on the role of the electroencephalogram. Brain Research, 1966, 2, 390-392.

Although our findings may be taken as evidence for the alpha-rhythm as an internal 'clock', the correlation obtained is very small. Since the coefficient of determination $r^2 = 0.235^2 = 0.055$, period of alpha-rhythm, under these circumstances, accounts for only 5.5% of the total variance in estimates of time. The fact that alpha-rhythm period varied only between 96-105 msec (9.5 - 10.4 c/sec) suggests that our correlation may have been reduced by the narrow range of this variable. On the other hand, the range of 8.72 - 11.43 sec of the estimates indicates considerable variation in time judgment. Thus, although data from more cases are required before any conclusions may be drawn, the present observations strongly suggest that some factor or factors other than the alpha-rhythm are required to account for variations in the experience of time.

- 1143 Surwillo, W. W. The influence of some psychological factors on latency of the galvanic skin reflex. Psychophysiology, 1967, 4, 223-228.

The purpose of this study was to examine the effect of differences in motivation and in attention on latency of the endosomatic GSR. Using verbal instructions, two different levels of motivation were induced in a group of 37 Ss who performed a simple reaction task in which they pressed a button whenever a 250 cycle tone was presented. The same tone also served as a stimulus for eliciting the GSR. In a second experiment, 42 different Ss performed a similar reaction task, but in this case the stimulus was the 250 cycle tone or a 1,000 cycle tone of equal subjective intensity. Ss were asked to give a voluntary response to all tones irrespective of frequency and then, later on, to respond only when the 1,000 cycle tone was presented.

Although voluntary reaction times were significantly shorter under conditions of high as compared with low motivation, latency of the GSR did not differ for the two conditions. In the second experiment, significantly shorter GSR latencies were recorded under the condition where Ss were required to pay closer attention to the stimulus.

- 1144 Surwillo, W. W. Relationship between EEG activation and reaction time. Perceptual and Motor Skills, 1969, 29, 3-7.

The relationship between RT and EEG activation, as defined by measurements of both amplitude and frequency (period) of waves from the dominant hemisphere, was investigated. A 250-c/sec tone that was presented without a preparatory warning signal was the stimulus. Within-subject correlations from 99 Ss supported the hypothesis of an association between EEG activation and behavioral arousal. Frequency of the waves was a better predictor of RT than amplitude.

- 1145 Surwillo, W. W. Statistical distribution of volar skin potential level in attention and the effects of age. Psychophysiology, 1969, 6, 13-16.

Skin potential (SP) level was investigated in 58 young (aged 22-53 years) and 64 old (aged 54-85 years) Ss. SP recordings were made during a 15-min interval while Ss were taking part in a watch-keeping task. The Kolmogorov-Smirnov test revealed that, while the distribution of SP level in young Ss deviated significantly from normality, the distribution in old Ss was normal. Evidence suggested that age of Ss needs to be taken into account when dealing with distributions of SP level recorded under attentive conditions.

- 1146 Surwillo, W. W. Frequency of the EEG during acquisition in short-term memory. Psychophysiology, 1971, 8, 588-593.

This study investigated changes in frequency of the EEG in relation to the number of digits inputted in a test of short-term memory. Four channels of bipolar EEGs were recorded from scalp leads over parietal and occipital areas of both hemispheres, while lists of the WISC digit span backward test were inputted. Data from 25 healthy Ss, who correctly recalled the 2-, 3-, 4-, and 5-digit lists in reversed order, were analyzed. Findings showed no statistically significant differences in frequency of the EEGs recorded during acquisition of lists of different length. EEG frequency was significantly faster during acquisition of the lists than during a control condition in which Ss participated in an auditory reaction time task; but the findings were not consistent from channel to channel.

- 1147 Surwillo, W. W. Human reaction time and endogenous heart rate changes in normal subjects. Psychophysiology, 1971, 8, 680-682.

The present findings are clearly in agreement with those of Nowlin et al. (1970). RT performance appears to be relatively independent of endogenous as well as exogenous changes in HR. Taken together, the evidence from both studies argues strongly in favor of the conclusion that background HR level is not an important determinant of RT. Finally, it is worth noting that this conclusion applies equally well to differences between subjects. Thus, the r between mean RT and mean HR for the group of 100 Ss tested was equal to $-.16$, which was not significantly different from zero.

- 1148 Surwillo, W. W. Reaction-time variability, periodicities in reaction-time distributions, and the EEG gating-signal hypothesis. Biological Psychology, 1975, 3, 247-261.

Variability in a person's reaction time (RT) was investigated in relation to a model which hypothesized that the speed of information processing is a function of two factors, namely, the time characteristics of a cortical gating signal, and the recovery period of the events activated by the gating signals. A total of 280 RTs were obtained from each of six young adult subjects while electroencephalograms (EEGs) were simultaneously recorded. Half of the trials were performed under conditions which yielded short, low variability RTs while the other 140 trials were obtained under conditions which produced longer, highly variable RTs. Distributions of RTs from the two conditions were examined in relation to distributions of EEG half waves - which were assumed to define the period of the cortical gating signal - taken from the interval between stimulus and response. Findings were consistent with the model under investigation, namely: (1) the two different conditions produced periodicities or multiple peaks in the RT distributions; (2) the magnitude of the time intervals between consecutive peaks in the subjects' RT distributions was correlated with the duration of the most frequently occurring half waves in their EEGs; and (3) inter-subject differences in variability of the RT distributions were associated with differences in variability of the EEG distributions.

- 1149 Surwillo, W. W. Cortical evoked response recovery functions: Physiological manifestations of the psychological refractory period? Psychophysiology, 1977, 14, 32-39.

A group of 12 young adults were subjects in two separate experiments. In the first experiment subjects listened to 71 dB clicks presented in stimulus sequences consisting of a single click and a pair of clicks. Interspersed at random among these loud clicks were soft clicks - singles and pairs of clicks - which subjects were required to detect and respond to by pressing a button. Average evoked potentials (AEPs) to the second click of the pairs of loud clicks were investigated as a function of the interstimulus interval (ISI), which had values of 50, 100, 250, 500, 750 and 1000 msec distributed at random. In the second experiment, similar sequences of clicks were used. Single clicks were soft clicks, pairs of clicks were loud clicks, and subjects were required to respond as quickly as possible to the second click of each pair. Reaction time (R^4) was investigated as a function of the ISI, which varied as in the first experiment.

Both the latency of the P1 and P2 components of the AEP and the RT were found to increase with decreasing ISI. These results were statistically significant at the .01 level of confidence. Analysis of covariance suggested that the latency differences in P1 associated with ISI could account for nearly half of the RT variance due to ISI. Findings suggest that latency differences in the P1 component of the AEP may provide a physiological basis for the delays known as the psychological refractory period which occur in the processing of closely-spaced stimuli.

- 1180 Surwillo, W. W., & Quilter, R. E. The relation of frequency of spontaneous skin potential responses to vigilance and to age. Psychophysiology, 1965, 1, 272-276.

Skin potential (Tarchanoff effect) was recorded in 132 healthy males, aged 22 to 85 years, while they performed an hour-long watchkeeping task. Vigilance level, as measured by S's detection or failure to detect certain critical stimuli, proved to be related to frequency of spontaneous skin potential responses (SPRs) in an interval immediately preceding the stimulus. Low vigilance was associated with fewer spontaneous SPRs per unit of time than high vigilance. This relationship did not appear to be the result of a correlation of the physiological and behavioral variables with time or with age.

Old persons evinced a smaller number of spontaneous SPRs in a standard time interval than young persons. Lacey and Lacey's hypothesis that autonomic "labiles," or Ss who show a large number of spontaneous autonomic responses, have shorter reaction times than autonomic "stabiles" was confirmed. A related hypothesis, in which number of erroneous motor responses was the dependent variable, was not substantiated.

- 1181 Sutton, S. The specification of psychological variables in an average evoked potential experiment. In E. Donchin & D. B. Lindsley (Eds.), Average evoked potentials: Methods, results and evaluations. Washington, DC.: US Government Printing Office, 1969.

The most consistent differences in evoked potentials from the two tasks were found in experiments where both tasks were difficult. The differences appeared most reliably at delays of 200 to 500 msec after stimulus presentation, in the latency range preceding the motor acts used for reporting the required decisions. They could not, however, be accounted for by potentials time-locked to the response acts themselves. Furthermore, the differences appeared in data that were averaged among subjects and across sessions. We suggest that the differences that have appeared in our experiments between evoked potentials recorded during loudness discrimination tasks and evoked potentials recorded from the same stimuli during pitch discrimination tasks might perhaps hold clues to task-related differences in late steps of underlying physiological mechanisms by which the stimuli are evaluated and the required decisions made.

- 1182 Sutton, S. The sensitivity of the evoked potential to psychological variables. Electroencephalography and Clinical Neurophysiology, 1971, 31, 302. (Abstract)

The P 3 component of the average evoked potential recorded at vertex is highly sensitive to the "salience" of the stimulus to the subject. Data are presented for a variety of experimental situations which show that: (1) P 3 is larger when the stimulus provides information in a guessing situation. If absence of a stimulus at a particular point in time provides the information, an endogenous P 3 appears at that latency. (2) When the guess is associated with a monetary pay-off, P 3 is larger for larger monetary pay-offs. (3) The amplitude of P 3 is monotonically related to the degree of unexpectedness of the outcome of the guess. (4) Pupillary dilation for the same trials parallel the relationship between P 3 and unexpectedness of outcome. This suggests the P 3 may be a central reflection of orienting. (5) P 3 is larger for relevant than for irrelevant stimuli. (6) The evoked potential to a click at absolute threshold is larger than for an irrelevant click 30 dB more intense. (7) The evoked potential wave form in a discrimination task is quite different between the stimulus being discriminated and the same stimulus used to deliver knowledge of results.

Data are presented to show that P 3 cannot be merely, or primarily, the return of the CNV to baseline. Predictable differences in P 3 are obtained when there are no corresponding differences in CNV.

1183 Sutton, S., Braren, M., Zubin, J., & John, E. R. Evoked-potential correlates of stimulus uncertainty. Science, 1965, 150, 1187-1188.

The average evoked-potential waveforms to sound and light stimuli recorded from the scalp in awake human subjects show differences as a function of the subject's degree of uncertainty with respect to the sensory modality of the stimulus to be presented. Differences are also found in the evoked potential as a function of whether or not the sensory modality of the stimulus was anticipated correctly. The major waveform alteration is in the amplitude of a positive-going component which reaches peak amplitude at about 300 milliseconds.

1184 Sutton, S., & Tueting, P. The sensitivity of the evoked potential to psychological variables. In P. H. Venables & M. J. Christie (Eds.), Research in psychophysiology. London: Wiley, 1975.

We have argued that in evoked potential research with awake human subjects it is at least inadvisable, and may even lead to incorrect conclusions, to conduct the experiment without reference to the subject's psychological relation to the stimulus. This has been supported by data which show that the evoked potentials are reliably sensitive to manipulations of psychological variables.

Illustrations have been given which lead to several conclusions. In the threshold experiments we found that:

(i) A correctly detected stimulus at absolute threshold yields a larger evoked potential than a much more intense, but irrelevant stimulus.

(ii) For both evoked potential and pupillary data, clear responses are found at absolute threshold only when a stimulus is present and it is detected to be present.

(iii) Identical stimuli yield very different evoked potentials when they are the stimuli to be detected as compared to when they deliver feedback about the correctness of the detection.

In the guessing experiments we found that:

(i) A stimulus whose identity is not known in advance yields larger evoked potentials than a stimulus whose identity is known in advance.

(ii) Even an absent stimulus (whether sound or light) yields an evoked potential related to the point in time at which its absence is noted. However the evoked potential to an absent stimulus only occurs when its absence is task relevant.

(iii) When intensity of the stimulus is task relevant, the evoked potential is larger than when its intensity is not task relevant.

(iv) A stimulus that confirms a high payoff guess yields a larger evoked potential than a stimulus which confirms a low payoff guess.

- 1155 Sutton, S., Tueting, P., Zubin, J., & John, E. R. Information delivery and the sensory evoked potential. Science, 1967, 155, 1436-1439.

The waveform of evoked responses recorded from human scalp is not determined solely by the physical eliciting stimulus, but also varies as a function of the effective information provided by the stimulus. There is a positive component whose latency is determined by the point in time at which ambiguity is reduced, and whose shape and amplitude are influenced by whether it is the presence or absence of an external event which delivers the information.

- 1156 Symposium on heart rate variability. Ergonomics, 1973, 16, 1-112.

Presents a series of 10 papers delivered at a symposium in October 1971 on heart rate variability and the measurement of mental load. Subjects covered include cardiac arrhythmia as a field technique, psychological factors influencing heart rate, effect of work and environmental heat on heart rate, and techniques for assessing heart rate variability.

- 1157 Sydulko, K., & Lindsley, D. B. Motor and sensory determinants of cortical slow potential shifts in man. In: J. E. Desmedt (Ed.), Progress in clinical neurophysiology. Vol. 1. Attention, voluntary contraction and event-related cerebral potentials. Basel, Switzerland: Karger, 1977.

The general conclusion of this study is that the topographical distribution of SPSs is sensitive to both the motor and sensory requirements of tasks involving preparatory intervals. Within the limits imposed by the relatively widespread electrode arrays employed in this study, fairly sharp regional differentiations could be made, particularly for SPSs related to visual stimulation and to unimanual motor preparation. Overlapping and interaction of different potential distributions also occurred, as in the case of SPSs over central and frontal regions associated with auditory stimulation and motor readiness. General characteristics of the potential distributions are similar to some of those described in animal studies (Sydulko, 1972), and thus invite comparisons possible deductions as to the physiological basis and functional significance of the SPSs and their accompanying behaviors.

- 1158 Szafran, J. Age differences in sequential decisions and cardiovascular status among pilots. Aerospace Medicine, 1965, 36, 303-310.

Attempts are currently being made to sketch an "aging profile" of capacities of pilots from physiological and psychological standpoints. In a sample of over 100 subjects representing a profession the practice of which requires making high-speed decisions, as well as an ability to receive and retain significant amounts of information whilst being fully engaged in routine control procedures, age differences in the relevant modalities of performance, as studied in the laboratory, are less impressive than might be expected from other data in the field of gerontology. Pilots over 40 years of age are relatively more susceptible than the younger to the effects of information overload, particularly if this involves short-term recall when some other activity intervenes during the period of retention. It is not clear, however, whether the conclusion that to this extent they may be said to possess less "spare mental capacity" than the young is really forced upon us by the data. Although the slowing with age, observed in the face of additional information challenge, is equivalent to lowering the rate of transmission of information it does not unequivocally suggest a reduced capacity for discrimination and choice. There is evidence that a change of "strategy" in detecting low probability and low intensity signals may occur as a cumulative result of prolonged experience, and that this change can be highly resistant to the adverse effects of aging in selected individuals. These subtle variations in the coding and decoding operations performed by the brain appear to be related to cardiovascular status among perfectly healthy men.

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- 1159 Takakuwa, E. Maintaining concentration (TAF) as a measure of mental stress. Ergonomics, 1971, 14, 145-158.

Fatigue has been discussed both in physiological and psychological terms. Undoubtedly these two aspects of fatigue interact upon each other and it may be difficult to distinguish between the two.

It is known that a certain degree of change in human functions caused by work-load may result in lowered activity, and produce a subjective feeling of fatigue. For fatigue evaluation, the latter may serve only as a reference, while the former may be measured in terms of performance, which must be a combined output of mental activity and physiological functions. A solution to this problem may be the TAF-test, which has been devised as a new quantitative fatigue test based on the concept of TAF. The average level of the TAF curve (TAF-L) and its standard deviation (TAF-D) are compared for pre- and post-work values and/or among different groups statistically.

As to the qualitative or psychological aspect, it is generally accepted that stress stimuli bring about certain neurophysiological changes. At present, the mecholyl test is recognized as a reliable means of showing the strength of homeostatic defence in the hypothalamus. However, in comparison to the dangers of the mecholyl test, the CPT-swing degree, which we have developed, may safely be used to identify the qualitative nature of the stress.

It is concluded that fatigue can be dealt with quantitatively by the TAF-test and qualitatively by the CPT-swing degree.

- 1160 Tanis, D. C. A signal-detection analysis of auditory evoked potentials in an intensity discrimination task (Doctoral dissertation, Washington University, 1972). Dissertation Abstracts International, 1972, 32, 7355B. (University Microfilms No. 72-17, 961)

Against a theoretical background provided by the Theory of Signal Detectability (TSD), an attempt was made to relate changes in late positive components of the auditory evoked potential to the degree of confidence a subject attaches to his decisions in a difficult auditory discrimination task. The following conclusions were drawn:

(1) The effects on the auditory evoked potential (AEP) of listening intently in an intensity discrimination task, as opposed to a passive control condition (reading), are minimal for strong signal levels of long duration. At low signal levels, the N1-P2 response is significantly enhanced relative to passive controls.

(2) Listeners can detect increments in signal level in a rating task as well with a single-interval procedure as when the standard tone is available for comparison on each trial.

(3) P3, that component of the AEP observed by others to be sensitive to psychological influences, was considerably enhanced relative to passive controls when subjects made a difficult discrimination at strong levels of auditory stimulation. At weak levels, P3 showed a similar reduction in amplitude to that of N1-P2; the latency of P3 also increased. At neither level of auditory stimulation was the amplitude of P3 found to be consistently related to psychophysical judgments of confidence.

(4) While the N1-P2 response to low-level tones was clearly enhanced when listeners were attempting to detect small increments in signal level, there were no obvious differences in N1-P2 associated with various response criteria in a binary-decision task or with the various levels of confidence in a rating task.

(5) With low-level signals and a binary-decision procedure, the amplitude of the N1-P2 response varied as predicted by TSD. According to TSD, the decision maker sets a criterion which effectively partitions the stimuli into four subsets, with average signal levels decreasing in the sequence: Yes and signal-plus-noise-plus-pedestal (SNP), Yes and noise-plus-pedestal (N'), No and SNP, and No and NP; the N1-P2 response decreased in this same order.

1161 Tarriere, C., & Hartemann, F. Importance du niveau de vigilance physiologique dans l'execution d'une tache de surveillance. [The importance of the level of physiological vigilance in the execution of a surveillance task.] Travail Humain, 1968, 31, 125-156.

The information given by the E.E.G. and the pulse rate are compared with the performance carried out by 126 subjects in a visual vigilance task of 150 minutes.

This study aims to answer the following questions: to what degree is the efficiency of subjects in connection, on the one hand, with the activation level of their central nervous system, and, on the other hand, with the focusing of their attention which is drawn at varying frequencies and for various lengths of time to other attractive points than the signals to be detected.

1162 Tarriere, C., Hartemann, F., & Niarfeix, M. Influence de la fumee de tabac sur l'evolution de la performance au cours d'une tache de surveillance. [Influence of tobacco smoking upon the course of performance in a watchkeeping task.] Travail Humain, 1966, 29, 1-21.

As part of a research inquiry into the possible deterioration of alertness in drivers owing to their exposure to carbon monoxide, the authors have studied and reported the effect of CO blood levels in smokers set a task requiring alertness under conditions partially simulating some aspects of driving an automobile. When the 24 smokers we studied performed their vigilance task while smoking, the efficiency level of their performance was better (despite a blood CO rate which was very high: 1.5 ml of CO per 100g of blood) than they turned in when deprived of tobacco beginning the night before the experiment. That superiority was observed as well in relation to a control group of 42 non-smokers: the performance of the latter group fell off during the 150-minute test, whereas the performance levels of the smokers showed no significant decline.

The cardiac rate curves show a pattern which corresponds to the performance curve pattern. This overall correspondence might indicate overall activation levels which differ from one to the other of the three groups tested.

The respective roles of nicotine and a possible personality factor common to most smokers are discussed so as to allow for the facilitating effect of tobacco on performance. Also discussed is the importance of cigarette smoking as a CO intoxication factor which aggravates the pollution level to which the driver of an automobile and the worker in industry are exposed.

- 1163 Taub, J. M., & Berger, R. J. Performance and mood following variations in the length and timing of sleep. Psychophysiology, 1973, 10, 559-570.

The relative effects of extended sleep, sleep deprivation, and shifts of accustomed sleep time on subsequent performance and mood were studied. Ten regular 2400-0800 sleepers worked on E-paced addition and vigilance tasks, and completed an adjective check list to rate their mood following 2100-0800 extended, 2100-0500 advanced-shift, 2400-0800 habitual, 0300-0800 deprivation, and 0300-1100 delayed-shift conditions of sleep. Accuracy and speed of response on the vigilance task were significantly poorer, and negative affect was significantly greater after the conditions of shifted sleep and altered sleep duration than after the habitual sleep condition. Changes in the mood and performance measures were unrelated to prior sleep length or any specific alterations in the electrophysiological patterns of sleep.

- 1164 Taylor, M. BP amplitude as a function of response contingencies. Psychophysiology, 1977, 14, 106. (Abstract)

Bereitschaftspotentials (BP) are generally viewed as concomitants of planned motor movement, whereas the CNV is associated with psychological constructs such as expectancy. Studies have shown, however, that the BP and CNV may be affected by the same variables: motivation, preparation, task difficulty and response requirements. This study investigates the BP and preparatory muscle potentials under conditions that, as in a CNV paradigm, place contingencies on the subject's response.

Scalp electrodes over the left and right motor cortex (C_3 , C_4) were used to record the EEG, with DC amplifiers, EOG was monitored from an infraorbital lead. Bipolar EMG was recorded from left and right forearm flexors.

Six experienced subjects were run twice on four randomly presented conditions: 1) voluntary key press; 2) voluntary key press which initiated 2 100-msec tones, randomly varied in frequency, separated by 1.0 sec; 3) identical to condition 2, except that the subject was instructed to press the same key as quickly as possible after the second tone; 4) the experimenter initiated the 2 tones and the subject pressed the key quickly after the second tone. All subjects were right-handed and responded with their right hands. Averages of 20 trials (3.25 sec sweep) were time-locked at 1.5 sec to the subject's voluntary key press in conditions 1-3, and the first tone in condition 4.

An analysis of variance yielded a strong interaction among the conditions, the EEG and EMG leads, and the three amplitude measures made per average ($F(18/90) = 10.4$, $p < .001$). BP and EMG activity increased over the first three conditions; CNV amplitude over conditions 2-4. A discriminant analysis, using seven of twelve EEG and EMG amplitude measures, correctly classified 90% of the averages in terms of conditions. Significant increase in BP duration over the first three conditions was also found ($F(2/10) = 6.24$, $p < .025$).

- 1165** Tchubarov, A. V., & Petelina, V. V. Ob otsenke kachestva raboty cheloveka-operatora po EEG. [On estimation of working ability of the man-operator by the EEG.] Fiziologicheskii Zhurnal SSSR, 1971, 57, 341-347.

Measured working ability as an integral of amplitude of discrepancy in time $F = \int A dt$, where F is the error in the operator's work in mm/sec, and A is the amplitude of the ray deviation in mm. The electrical activity was tested with the P parameter indicating a relationship between the averaged EEG amplitude and frequency. The F and P parameters were counted with the aid of a computer complex. Despite the obvious individual peculiarities of motor reactions and the different levels of CNS tonic activity, a regular dependence was shown between working ability and electrical activity recorded during presentation of the task; with increasing P parameter the F value also increased.

- 1166** Tecce, J. J. Attention and evoked potentials in man. In D. I. Mostofsky (Ed.), Attention: Contemporary theory and analysis. New York: Appleton-Century-Crofts, 1970.

Experiments bearing on the relationship between attention and the amplitude of averaged evoked potentials (EP) in man have been reviewed. Attention directed to the source of stimulation of the EP, e.g., counting lightflashes, often, but not always, leads to an increase in the EP. Attention focused by psychomotor tasks, e.g., reaction time, is usually more efficient when the EP is high. A slow, surface-negative DC potential (Contingent Negative Variation) is high during focused attention, varyingly defined. There is no consistent relationship between the EP and attention, defined by hypnosis and suggestion.

Inattention by distraction often reduces the EP, but there also exists negative evidence. Inattention by habituation usually reduces the EP. The effects of sleep on the EP are complex and seem to be, in part, a function of background EEG. There is no clear relationship between impaired attention by drugs and the EP, except for a fairly consistent, selective reduction by LSD. Mesencephalic reticular stimulation reduced the EP in the single study reviewed. No consistent relationship exists between the EP and schizophrenia. There is some suggestion of a relationship between background EEG (especially if it is synchronous and high voltage) and the EP. There is a dissociation between the EP and attention (low level of attention accompanied by elevated EP) when background electrical activity is synchronous and/or high voltage and attention is lowered, as during relaxed wakefulness and deep stages of sleep.

- 1167** Tecce, J. J. Contingent negative variation and individual differences. Archives of General Psychiatry, 1971, 24, 1-16.

Contingent negative variation (CNV) is a slow surface-negative cortical potential in the human brain that is related to individual differences in psychological functions. Major sources of interindividual variability in CNV development among normal adults, children and psychiatric patients involve attention and arousal functions. Consequently, a two-process theoretical model is postulated to account for individual differences in CNV, namely, that CNV amplitude is positively and monotonically related to attention functions and nonmonotonically (inverted-U) related to arousal functions. CNV also appears to be reflecting motor processes. Although CNV is a potentially useful tool in psychiatric research, eye movements can drastically alter CNV and are a serious methodological problem requiring further study. The neurophysiological genesis of CNV involves both cortical (apical dendrites in upper layers of frontal cortex) and subcortical (brain stem reticular formation) mechanisms.

- 1168 Tecce, J. J. Contingent negative variation (CNV) and psychological processes in man. Psychological Bulletin, 1972, 77, 73-108.

Contingent negative variation (CNV) is a slow, surface-negative electrical brain wave. The basic experimental paradigm for generating CNV is like that of a constant-foreperiod reaction time task and involves the presentation of a warning stimulus (S_1) followed by an imperative stimulus (S_2), to which a motor response is usually required. CNV appears within the S_1 - S_2 interval as a negative shift in the electroencephalogram (EEG) base line that averages approximately 20 microvolts (μv). Interpretations of CNV findings have involved the psychological processes of expectancy, conation, motivation, and attention. A two-process theoretical model is proposed to account for CNV results: Magnitude of CNV is positively and monotonically related to attention and nonmonotonically (inverted U) related to arousal level. CNV is also associated with other kinds of electrophysiological activity, notably autonomic activity and slow cerebral potentials that accompany voluntary motor movements. Although CNV is clearly a cerebral phenomenon, eye movements can seriously distort its measurement. It is concluded that CNV is an electrical phenomenon of the human brain that is related chiefly to attention and arousal functions.

- 1169 Tecce, J. J., & Hamilton, B. T. CNV reduction by sustained cognitive activity (distraction). Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 229-237.

Eighteen normal volunteers were studied in a typical CNV situation, involving a light flash followed after 1.5 sec by a tone terminated by a key-press (control condition). The use of cognitive activity (adding 7s ad seriatum) as a sustained distraction from the primary task of responding to S_2 resulted in CNV reduction and lengthened RT to S_2 . This finding was interpreted as a "distraction effect" and as support for an attention hypothesis of CNV development. The reduction in CNV amplitude produced by adding 7s was accompanied by elevated heart rate levels, a finding interpreted as showing that CNV amplitude is inversely related to arousal level. The results from the present experiment and findings reviewed from other studies on CNV led to the formulation of two hypotheses to account for CNV development, namely, that CNV magnitude bears a positive relationship to attention to S_2 and an inverted-U relationship to arousal level.

- 1170 Tecce, J. J., & Scheff, N. M. Attention reduction and suppressed direct-current potentials in the human brain. Science, 1969, 164, 331-333.

Distraction suppresses direct-current potentials (contingent negative variation) recorded from the human scalp. This reduction is accompanied by retarded reaction time. Contingent negative variation and reaction time appear to reflect a common process, attention.

- 1171 Tent, L. Versuche zur fruherfassung von merkmalen mentaler uberbeanspruchung: Ein beitrag zum problem der vorzeitigen invaliditat. [Investigation concerning early detection of characteristics of mental over work: A contribution to the problem of early disability.] Archiv Fur Die Gesamte Psychologie, 1968, 120, 1-24.

Assesses variables of permanent mental overwork, which, in extreme cases, may contribute to early disability. The risk of mental overwork is defined as the permanent 1-sided deviation from the convergency rule stating that mental expenditure and achievement tend to adapt on a harmonized individual level of activity. Disproportionately high relative expenditure may lead to an overdrawing of the regulating tolerance and result in early disability with forced convergency on a low activity level. In a 4-hr laboratory experiment with 30 students, the final quotient of (normalized) expenditure (pulse rate) and (normalized) achievement - dependent variable - could be predicted by means of weighted data from a different experiment - independent variables ($R = .7$, $P < 1\%$). This relationship was not reproduced satisfactorily in a subsequent investigation of 102 industrial workers using ratings of superiors as a makeshift criterion. The multiple correlation between rated susceptibility and 4 variables: body-weight, blood-pressure, concentration test score, and achievement motivation, was only $R = .4$ ($P < 5\%$). In a discriminatory analysis, the means of weighted predictor scores of 2 extreme subgroups ($N = 20$; 22) differed very significantly with still considerable overlap. This approach was discussed in terms of G. P. Lienert's regression theory, and M. Haider's deactivation theory of fatigue.

- 1172 Thackray, R. I. Patterns of physiological activity accompanying performance on a perceptual-motor task (Report No. 69-8). Oklahoma City, Okla.: FAA Civil Aeromedical Institute, 1969. (NTIS No. AD-697945)

Skin conductance, heart rate, respiration rate, and blink rate were recorded from 15 Ss during performance at a demanding tracking task. Performance trials comprised 15 2-min periods of tracking per S with each period separated by 35-sec of rest. "Results suggest a central process which exerts a suppressive or regulatory influence on . . . physiological variables during attention, with a release of the suppression . . . during rest."

- 1173 Thackray, R. I., Bailey, J. P. & Touchstone, R. M. Physiological, subjective, and performance correlates of reported boredom and monotony while performing a simulated radar control task. In R. R. Mackie (Ed.), Vigilance: Theory, operational performance, and physiological correlates. New York: Plenum Press, 1977.

The present study examined the degree to which reported boredom is related to monitoring efficiency on a complex task and explored the general pattern of physiological and subjective changes associated with boredom. Forty-five male subjects performed a simulated air traffic control task for 1 hour. The subject's task was to respond to infrequent changes in alphanumeric symbols on the simulated radar display. Physiological recordings of blood pressure, oral temperature, skin conductance, body movement, heart rate and heart-rate variability, and performance measures of mean and variability of response times were obtained. In addition, subjects rated their levels of boredom, monotony, irritation, attentiveness, fatigue, and strain at the beginning and end of the session. Two extreme groups of eight subjects each were formed on the basis of their rated boredom and monotony and were compared with respect to changes in each of the measures during the task period. The two groups differed significantly on several measures with the high boredom-monotony group showing greater increases in "long response times," heart-rate variability, and strain along with a greater decrease in attentiveness. The nature of the pattern associated with boredom and monotony suggests a pattern more closely related to attentional processes than to "arousal."

- 1174 Thackray, R. I., & Jones, K. N. Level of arousal during Stroop performance: Effects of speed stress and "distraction". Psychonomic Science, 1971, 23, 133-135.

Heart rate and respiration were obtained during Stroop performance. Although the test is often reported to evoke strong feelings of frustration, no evidence of increased autonomic arousal was found to be associated with the color-word interference effect, and this did not change with the addition of auditory "distraction." Increasing stimulus presentation rate increased arousal, but this was independent of color-word interference.

- 1175 Thackray, R. I., Jones, K. N., & Touchstone, R. M. Personality and physiological correlates of performance decrement on a monotonous task requiring sustained attention (Report No. 73-14). Oklahoma City, Okla.: FAA Civil Aeromedical Institute, December 1973. (NTIS No. AD-777 825)

The reductions in task load resulting from the increasing automation of air traffic control may actually increase the requirement for controllers to maintain high levels of sustained attention in order to detect subsequent system malfunctions. A previous study indicated that individuals scoring high on a distractibility scale found it difficult to maintain sustained attention on a monotonous, but perceptually demanding, task. The present study used the same serial reaction task to study other possible personality, as well as physiological correlates of individual differences in performance decrement under low task-load conditions. Sixty subjects performed the task continuously for 40 minutes. Extraverted subjects showed increasing lapses of attention, while introverted subjects failed to show any evidence of a decline in attention. Of the two extraversion components (impulsivity and sociability), impulsivity was the component responsible for the obtained decrement. Heart-rate variability showed a significant relationship with performance decrement while mean heart rate did not.

- 1176 Thackray, R. I., Jones, K. N., & Touchstone, R. M. Self-estimates of distractibility as related to performance decrement on a task requiring sustained attention. Ergonomics, 1973, 16, 141-152.

Increasing automation of air traffic control tasks may have the undesirable side effect of increased monotony as a result of the anticipated reduction in task demands. Since individuals who are unable to sustain attention under low task-load conditions would appear to be more likely to commit errors and be less able to handle a sudden emergency situation, it would seem desirable to examine the characteristics of individuals unable to sustain attention under these conditions. In the present study, 50 subjects performed a monotonous, but perceptually demanding task, for approximately 30 minutes without rest. It was found that high-distractibility subjects (as determined from a questionnaire administered prior to the experiment) showed increasing lapses of attention during performance, while low-distractibility subjects failed to show any evidence of a decline in attention. Significant changes were obtained for respiration, respiration-period variability, heart-rate variability, and skin conductance during the task period, but the magnitude of these changes did not differ among the two distractibility groups.

- 1177 Thackray, R. I., Jones, K. N., & Touchstone, R. M. Personality and physiological correlates of performance decrement on a monotonous task requiring sustained attention. British Journal of Psychology, 1974, 65, 351-358.

A serial-reaction task was used to study personality, as well as physiological, correlates of individual differences in performance decrement under low task-load conditions. Sixty subjects performed the task continuously for 40 min. Extraverted subjects showed increasing lapses of attention, while introverted subjects failed to show any evidence of a decline in attention. Of the two extraversion components (impulsivity and sociability), impulsivity was the component responsible for the obtained decrement. Heart-rate variability showed significant relationships with personality and with performance decrement, while mean heart rate did not.

- 1178 Thackray, R. I., & Pearson, D. W. Effects of cognitive appraisal of stress on heart rate and task performance. Perceptual and Motor Skills, 1968, 27, 651-658.

The effects of threat of shock on heart rate and motor performance were studied on Ss differing in previously expressed fear of shock. Twenty-four high fear-of-shock (HFS) and an equal number of low fear-of-shock (LFS) Ss were given 15 training trials on a conventional pursuit rotor. Following training one third of the Ss were informed that during subsequent trials shock would be administered if performance fell below training levels, one third were told that shock would be randomly administered, and the remaining third served as a control. No shocks were actually administered. HFS Ss revealed significantly greater heart-rate acceleration and performance impairment, but only under the condition in which Ss were told that receipt of shock would be contingent on prior performance level.

- 1179 Thackray, R. I., & Touchstone, R. M. Recovery of motor performance following startle (Report No. 69-21). Oklahoma City, Okla.: FAA Aeromedical Institute, October 1969. (NTIS No. AD-704 472)

Following training of 30 Ss on RT and tracking tasks while recording heart rate and GSR, startle stimuli (noise) were presented during performance. Performance recovered within 15 sec and startle RTs were shorter than those for nonstartle stimuli. Ss least proficient in performance showed the greatest increase in error and reacted most strongly to the startle stimuli.

- 1180 Thayer, R. E. Activation states as assessed by verbal report and four psychophysiological variables. Psychophysiology, 1970, 7, 86-94.

The present research was part of a program aimed at examination of the validity of controlled verbal reports of various activation states. A difference score design was used in which four psychophysiological measures and verbal ratings of various activation states were obtained in a baseline and an activation period from 41 female subjects. Verbal reports were then correlated with individual physiological measures and composites or indices of physiological measures. Specifically, two kinds of physiological index were employed, one in which the subject's physiological change score was represented by the single system showing the greatest change, and a second index weighted equally by all four physiological measures. The physiological index using the single system showing the greatest activation yielded slightly greater correlations with verbal report than the other index. Skin conductance and heart rate, the best combination of the four physiological systems measured, correlated as high as .62 with verbal report. The results were interpreted as demonstrating the usefulness and validity of controlled self report and the relative superiority of skin conductance and heart rate among other physiological systems in correlations with verbal report.

- 1181 Thetford, P. E., Klemme, M. E., & Spohn, H. E. Skin potential, heart rate, and the span of immediate memory. Psychophysiology, 1968, 5, 166-177.

Relations between orienting response and span of immediate memory were studied by measuring skin potential responses (SPR) and heart rate (HR). Four conditions were studied by presenting letters in a tachistoscope and a 1000 cycle, 100 db tone simultaneous on some but not all trials. The conditions (15 Ss in each) were: tone and letters for 10 trials, then letters alone for 10 trials; tone and letters for 20 trials; only letters for 10 trials, followed by letters and tone for 10 trials; and only letters for 20 trials.

The results showed: (1) positive SPR habituated and negative did not, (2) tone produced more SP activity, (3) HR showed a shift from acceleration to deceleration over 20 trials, but tone had no influence, (4) tone had no direct influence on span scores, (5) Ss showed improvement in number of letters reported correctly. There was a significant correlation between span and negative SPR when tone was sounded ($r = .36$).

- 1182 Thompson, D. J. Influence of selective attention on the averaged electroencephalic response (Doctoral dissertation, The University of Wisconsin, 1972). Dissertation Abstracts International, 1973, 34, 45B. (University Microfilms No. 73-10, 744)

A selective attention paradigm was used to investigate the relation of attention to the averaged electroencephalic response (AER) in 14 young adult subjects (9 male, 5 female). Two areas of the time-divided AER were examined: (1) the filtered (20-150 Hz) early AER (8-40 msec); and (2) the filtered (1-20 Hz) late AER (40-400 msec). Amplitude differences between attending and nonattending conditions, and between hemispheres within attending conditions, were of primary interest.

Stimuli were simultaneous phase-locked 100 msec (D_1) or 130 msec (D_2) 1000 Hz tones (rise-fall time = 1.5 msec) generated onto two channels of a tape. The interval between the termination of one tone and the onset of the next was 800 msec. D_2 occurred randomly with D_1 independently on each of the two channels, but D_2 never occurred simultaneously on both channels. One of these channels was routed to one ear of a subject and the other to the subject's opposite ear.

Each subject experienced six conditions: reading (R), sit-monotic (SM), sit-dichotic (SD), attend-first (A1), attend-second (A2), and attend repeat (Arp). Subjects performed three tasks among these conditions: (1) reading during condition R; (2) sitting quietly, eyes open, during conditions SM and SD; and (3) marking the unilateral occurrence of D_2 , by pressing a silent switch, during conditions A1, A2 and Arp. The task of condition A1 involved paying close attention to the right (or left) ear, and pressing the switch when the longer duration tone (D_2) occurred in that ear. Condition A2 had the subject track D_2 in the ear contralateral to the one used in A1. Arp was a repeat of A1. The first two conditions were to settle the subject, and were not included in the analysis of the data. The AERs obtained from the A1, A2, and Arp conditions were later compared to the AERs from condition SD (SD-attend). The possibility of amplitude interhemispheric asymmetries was investigated by comparing mean AERs for each hemisphere within each attention condition.

Impressions gained from analysis of the data allowed three tentative conclusions: (1) there was an attentional effect upon the late AER—a trend toward diminution of the amplitudes of one late peak-to-peak amplitude component ($P_{180}-N_{253}$); (2) there was no effect of attention upon the early AER; and (3) there was no systematic amplitude interhemispheric asymmetry associated with either early or late AERs within attention conditions. The cause of

the late AER amplitude diminutions, when subjects were attending, was speculated to be a reduction in the contribution of the activity of the nonspecific cortices to the amplitude of the late AER.

- 1183 Thompson, L. W., & Botwinick, J. The role of the preparatory interval in the relationship between EEG alpha blocking and reaction time. Psychophysiology, 1966, 3, 131-142.

The association between alpha-blocking and improved reaction times (RTs) has not been consistently demonstrated in past studies. The possible importance of the preparatory interval (PI) in this relationship has not been totally assessed, and it was felt that further exploration of this variable would help to explain the discrepancies. RTs were measured in two experiments, each using different types of stimuli and different PI durations. In the first, 4 PIs, 0.5-, 3.0-, 6.0-, and 15.0-sec, were used in a regular and irregular series. The warning signal was a 400-cps tone; the stimulus, a 1000 cps tone. In the second, PIs were 0.50-, 0.75-, 1.00-, and 1.50-sec; the stimulus was a single flash from a photo stimulator. EEGs were recorded simultaneously from the parieto-occipital region. Both peak-to-peak amplitude measures and subjective ratings of alpha-activity were made prior to the onset of the warning signal and the stimulus. The results did not support earlier findings of a relationship between alpha-blocking and RT. However, RT and alpha-blocking were each (independently) a function of the PI.

- 1184 Thompson, L. W., & Botwinick, J. Age differences in the relationship between EEG arousal and reaction time. Journal of Psychology, 1968, 68, 167-172.

An EEG measure of arousal was investigated in relation to the preparatory interval (PI) in the context of a reaction time (RT) study for each of two age groups. The two groups (19-35 and 62-87 years) reacted differently to the PI variations with respect to the arousal measure, but not with respect to RT. Measures of arousal and RT were uncorrelated. These results, plus the finding of a statistically significant age difference in RT but not in the EEG measure, lead to the conclusion that, in this study at least, EEG changes did not explain the slowing in old age.

- 1185 Thompson, L. W., & Botwinick, J. Stimulation in different phases of the cardiac cycle and reaction time. Psychophysiology, 1970, 7, 57-65.

Several studies have suggested that reaction time (RT) may be related to variations in blood pressure which occur with each heart beat. This was tested in a series of four studies in which possible effects of the preparatory interval (PI) were controlled. Stimuli were presented at 0, 200, 400, and 600 msec following the R wave, and during the ascending slope of the R, T, and P waves of the cardiac cycle. No relationship was found in any of the four studies between RT and the phase within the cardiac cycle when the stimulus occurred.

- 1186 Thompson, L. W., & Thompson, V. D. Comparison of EEG changes in learning and overlearning of nonsense syllables. Psychological Reports, 1965, 16, 339-344.

A comparison between EEG changes occurring during learning and overlearning of nonsense syllables was made, with emphasis on activity related to occasional errors of well-learned material. Seventeen college students learned 12 nonsense syllables by the serial anticipation method, followed by 20 trials of overlearning. EEGs were recorded simultaneously and analyzed by a Burch Period Analyzer. Increased fast and decreased alpha activity were observed during learning. During overlearning, tracings returned toward control levels. Activity associated with errors during overlearning showed a marked increase in fast and decrease in alpha comparable to the changes noted in earlier stages of learning. The data are discussed in terms of the functional significance of the reticular system.

- 1187 Thorsheim, H. I. EEG and vigilance behavior. Psychonomic Science, 1967, 3, 499-500.

An attempt was made to relate a physiological index of arousal and a behavioral index to test the arousal theory of vigilance. A visual monitoring task was used and the arousing activity was motor movements between signals. The motor manipulation was found to influence physiological arousal, but not the behavioral measure of monitoring efficiency.

- 1188 Tinsley, J. H. An investigation of physiological correlates of vigilance performance. Monterey, California: Naval Postgraduate School, October 1969. (NTIS No. AD-706054)

A pilot investigation of physiological parameters was conducted to determine possible correlates of vigilance performance. Six parameter measurements were continuously recorded during a 48-min vigil as 6 Ss monitored a voltmeter display. Simple and multiple linear correlation analyses were performed to determine the relationship between parameters observed and the percentage of signals detected. Results showed systolic blood pressure ($r = .382, p < .08$), skin temperature ($r = .378, p < .08$), and diastolic blood pressure ($r = .330, p < .13$) were each correlated with vigilance performance. No correlation was found between performance and skin resistance, heart rate, or pulse pressure. A multivariate analysis indicated that the addition of skin temperature to systolic blood pressure provided a multiple correlation of $R = .497, p < .06$, between those parameters and performance, and the further addition of pulse pressure as a third variable increased R to $.541, p < .08$. These results and some additional, ad hoc analyses are interpreted in the context of the Arousal Theory of vigilance.

- 1189 Travis, R. C., & Kennedy, J. L. Prediction and automatic control of alertness: I. Control of lookout alertness. Journal of Comparative and Physiological Psychology, 1947, 40, 457-461.

Using a Grass amplifying system and an electronic accumulator, the experimenters studied the relationship between reaction time and muscular tension-level in a simulated lookout situation. After establishing normal reaction times to light in the usual manner, the light stimulus was automatically given when action potentials from electrodes placed just above the eyebrows decreased by a certain pre-determined amount. The trend of the results indicated longer reaction times with lower muscular tension levels. The apparatus seems "promising enough to point the way in the development of a practical technique to detect states of alertness and automatically warn the subject of an approaching dangerous inattention during monotonous tasks."

1100 Travis, R. C., & Kennedy, J. L. Prediction and control of alertness: III. Calibration of the alertness indicator and further results. Journal of Comparative and Physiological Psychology, 1949, 42, 45-57.

1. In calibrating the frequency characteristics of the alertness indicator for the range of frequencies from 25 to 400 cps there was a marked uniformity of response in the critical voltage range of 4 to 8 microvolts.

2. The comparison of two independent simultaneous pen records of frequency networks 40 cps and above, and 150 cps and above, with a human subject, showed marked similarity and a high correlation, indicating the input voltage is the important variable.

3. Changes in electrode resistance as high as 40,000 ohms during an experimental session seem to have little or no effect on the alertness indicator function, assuming a good contact is maintained.

4. It was demonstrated in a lookout task that a uniform gain setting to permit an input voltage of 6-7 microvolts to close the accumulator relay was feasible from subject to subject.

5. Tentative results showed a definite association between electrical potential output from the subject and length of time to assemble units in a simple assembly task.

6. In comparing tension levels while performing different tasks, simple tracking was found to produce a significantly higher tension level than reading, solving simple mathematics problems, and simulated lookout. The latter three tasks were about equal in tension level.

1101 Travis, R. C., Kennedy, J. L., Mead, L. C., & Allphin, W. Muscle action potentials as a measure of visual performance cost. Illuminating Engineering, 1951, 46, 182-187.

If similar results are obtained when tests are extended over periods of several hours, it would indicate that as far as physiological cost alone is concerned, there is no need for high footcandle levels when reading a well-printed book in a comfortable surround. However, tasks of greater difficulty will require more than minimum illumination for lowest physiological cost.

The following are suggested for further investigation:

1. A continuation of the tests already described.
2. Reading 10-point type in a comfortable surround at low illumination levels for long periods of time.
3. Reading at different illumination levels in a dark surround for long periods.
4. An analysis of industrial and commercial tasks in terms of tension level as affected by illumination.

- 1102 Troy, M., Chen, S. C., & Stern, J. A. Computer analysis of eye movement patterns during visual search. Aerospace Medicine, 1972, 43, 390-394.

Eye movements were recorded from 13 novice and 13 skilled helicopter pilots during a cross-country flight. This analysis is restricted to an evaluation of the pattern of eye movements as a function of (a) skill and (b) time on task. No differences were found as a function of skill. The incidence of non-patterned search activity was found to decrease as a function of time on task. The results are discussed in terms of a decrease in alertness to "unexpected" environmental stimuli. The development of a reliable computer-based procedure (utilized in the present study) for analyzing eye movements is also discussed.

- 1103 Tsaneva, N., Danev, S., & Dobrovolski, I. Recherche sur le travail des operateurs dans l'industrie chimique. [Study of the operators' task in the chemical industry.] Actes du Troisieme Congres de la Societe d'Environnement de Langue Francaise, Bruxelles: Presses Universitaires de Bruxelles, 1968, 122-124.

This study examined the relationship between heart rate and mental load (as determined by the complexity of three different operator task loads). It was found that heart rate at the end of the task period was significantly higher for the most complex task as compared to the other two task loads.

- 1104 Tueting, P., & Sutton, S. The relationship between prestimulus negative shifts and poststimulus components of the averaged evoked potential. In S. Kornblum (Ed.), Attention and performance IV. New York & London: Academic Press, 1973.

Four formulations were considered concerning the possible relationship between averaged pre- and poststimulus waveforms. An adequate formulation must account for data showing that although a prestimulus negative shift tends to be associated with changes in the vertex averaged evoked potential, especially a positive enhancement of P_3 (and possibly of the P_2 and N_2 components), pre- and poststimulus activity can also be dissociated. For example, it is possible to find functional relationships between evoked potential amplitude and certain experimental variables while controlling for differential contribution of prestimulus activity by presenting stimulus conditions in an unpredictable trial sequence. Further research is required in order to determine the exact nature of association and dissociation between pre- and poststimulus activity with particular attention to the possibility of an overlapping of components from different neurological sources in some experimental designs.

- 1105 Tueting, P., & Sutton, S. Auditory evoked potential and lift/no-lift reaction time in relation to uncertainty. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

Averaged evoked potentials and lift/no-lift RT were studied in relation to uncertainty. The results were: (1) Median RT was longer in the uncertain condition than in the certain condition. (2) P_3 amplitude was larger for the uncertain condition at F_z , C_z , P_z and O_z loci for both lift and no-lift trials. (3) In the uncertain condition P_3 amplitude in the no-lift trials had a more anterior distribution than P_3 in the lift trials. (4) In the certain condition P_3 amplitude in the lift trials was larger than in the no-lift trials. (5) CNV was larger in the uncertain condition than in the certain condition, and in the certain condition lift trials had larger CNV than no-lift trials.

- 1192 Tueting, P., Sutton, S., & Zubin, J. Quantitative evoked potential correlates of the probability of events. Psychophysiology, 1970, 7, 385-394.

A late positive-going component (P_3) of the average evoked potential recorded from human scalp was shown to be quantitatively related to a priori stimulus probability both when the S was told the identity of the stimulus before it was presented and when the S was not told, and was instructed to guess. In the guessing situation, the amplitude of P_3 was much larger and was influenced not only by the priori probability of events determined by the experimenter but also by the interaction of these probabilities with the S's guessing behavior. The amplitude of the late positive component was inversely related to the proportion of trials in which a particular event was associated with a particular guess, i.e., the proportion of hits and misses. It was larger the more unexpected the outcome of the guess. This relationship held for different methods of manipulating the probability of two events.

- 1197 Tursky, B., Schwartz, G. E., & Crider, A. Differential patterns of heart rate and skin resistance during a digit-transformation task. Journal of Experimental Psychology, 1970, 83, 451-457.

Fifteen Ss performed a paced digit-transformation task at two levels of difficulty under an overt or covert response requirement. Time-locked recordings of heart rate and skin resistance showed heart-rate deceleration during the information-intake phase of the task and acceleration during cognitive processing. Skin resistance showed a generalized arousal pattern during both information intake and processing. Response magnitudes in both measures were generally enhanced in the more difficult condition and under the requirement to make an overt response indicating task fulfillment. The results support Lacey's hypothesis of directional fractionation of autonomic response as a function of the internal-external attention demands of imposed tasks.

- 1198 Tuton, K. V. Level of activation during signal detection tasks (Doctoral dissertation, The Pennsylvania State University, 1969). Dissertation Abstracts International, 1970, 31, 2011B-2332B. (University Microfilms No. 70-19, 48)

This thesis was an attempt to explore the relation between level of activation, and performance on two signal detection tasks. In this experiment, electric shocks of five different intensities were used to manipulate within S level of activation. In addition, there were two signal detection tasks differing in discrimination difficulty. The 3-tone task required one group of Ss to discriminate the signal from two other tones, the 7-tone task required the other group of Ss to discriminate the signal from six other tones. The specific hypotheses tested were as follows:

1. Activation level, as measured by finger pulse volume and galvanic skin resistance, will be a direct function of shock intensity.
2. The curvilinear inverted U function relating activation level and performance will hold only for the 7-tone task group. The relation between activation level and performance for the 3-tone task group will be linear.
3. The 7-tone task group will have longer latencies and make more errors in task performance than the 3-tone task group.
4. The 3-tone and 7-tone task groups will not differ significantly in level of activation as measured by finger pulse volume and galvanic skin resistance.

Two psychophysiological measures of level of activation were used, finger pulse volume and galvanic skin resistance; both were measured as a percentage of a prior resting level. Three measures of performance on the signal detection task were used, response latency, false positive errors, and non-response errors. The order of assignment of shock levels within Ss was determined by means of a Latin Square.

Three of the four hypotheses of the present study were confirmed. Hypothesis two, the most important one for the confirmation of activation theory, was not wholly confirmed. Instead, Lacey's (1967) criticisms of activation theory were supported. Results of the present experiment strongly suggest that activation theory be modified.

U

- 1199 Uttal, W. R. Do compound evoked potentials reflect psychological codes? Psychological Bulletin, 1965, 64, 377-392.

The purpose of this paper is to examine the question of the utility of the compound evoked potential as a sign of perceptual experience. A discussion is presented of the origin of the peripheral nerve compound action potential and the brain potential evoked by impulsive stimuli. Some of the recent literature on the potentials from human Ss is considered to determine what progress has been made in correlating these electrical signs with psychophysical responses. It is concluded that while certain suggestions have been forthcoming, both denying and affirming the relation, the evidence is still inconclusive that simple correspondences exist between the two.

- 1200 Uttal, W. R. Evoked brain potentials: Signs or codes? Perspectives in Biology and Medicine, 1967, 10, 627-639.

The main point that, I hope, has been conveyed by this essay concerns the philosophic notion of the nature of a code. It seems inadequate at the present time to discuss physiological signals in terms of simple correlations. To do so retains, longer than it so deserves, the dualism of parallelism or psychoneural isomorphism. Rather, an analysis of the specific ways in which these signals might be related to the behavior of which they are concomitants is an important theoretical framework which potentially can guide the work in this rapidly developing and important field. A further analysis of correlates into either stimulus or systemic codes or signs seems appropriate in the context of current research. Codes are defined as signals which are sufficiently associated with the related behavior so that we may assume a monistic identity. A stimulus sign is defined as a fluctuation in the signal which is a function of the stimulus but which can be shown to have no effect on the related behavior. Systemic signs are fluctuations produced by non-stimulus conditions which are also only indirectly related to the behavior. Special care must be taken to avoid confusion of codes and systemic signs which are mediated via some intermediate mechanism of unknown significance.

A complete distinction between a code and a sign requires tests both of necessity and sufficiency and may, indeed, be a most formidable, though not inconceivably difficult, task. I submit that the most effective and logically sound sufficiency test available to us now is a psychophysical test of the discriminability of neural patterns rather than the usual electrophysiological experiment.

- 1201 Uttal, W. R., & Cook, L. Systematics of the evoked somatosensory cortical potential: A psychophysical-electrophysiological comparison. Annals of the New York Academy of Sciences, 1964, 112, 60-80.

1. The evoked somatosensory potential was studied by an averaging technique and, although reliable results were recorded from individuals, wide ranges of individual differences were found among the various subjects studied.

2. A response type was selected in which all components were present and sufficiently resolved to be independently measured. This typical evoked potential was a combination of what appears to be three basic waveforms which we have called M, N, and O waves.

3. A "saturation" phenomenon was discovered which complicated the issue of the coding of sensory intensity when these results were compared to analogous psychophysical data.

4. Sequential interactions from temporally separated ipsilateral stimuli were shown to exist in the form of an extended refractory period.

5. No interaction could be detected between stimuli presented to opposite sides of the body.

6. Psychological studies confirmed that there was no interaction between stimuli presented to opposite sides of the body.

7. Sleep was shown to affect the M and N waves in only trivial ways, while the O wave was completely abolished by sleep.

8. As usual, the exploration of this new area has led to many unanswered questions. The preliminary nature of our results and the limitations of the evoked potential technique emphasizes the large amount of research which is yet to be done in this area.

V

- 1202 Vaida, I., & Pafnote, M. Studiul influentei conditiilor de microclimat in activitatea operatorilor din termocentrale. [A study of the effect of microclimatic conditions on the work of operators in thermal power stations.] Igiena, 1970, 19, 657-666.

The influence of environmental conditions on perceptual performance was studied in the operators working at the control panels in two thermoelectrical power plants (92 employees).

The latency periods of the reflex motor reactions to serial sonorous and photic stimuli and critical flicker fusion frequency were recorded dynamically in the course of the shift, carrying out parallel investigations on the microclimate factors and thermo-regulation function (volume of perspiration and skin temperature).

The results showed that the force of the excitation process and the lability of the central nervous system tended to diminish towards the end of the day's work; these changes were more significant in the warmer, boiler and turbine section than in the control section where the conditions were close to the comfort zone. The tendency towards inhibition was more marked where air temperatures were higher and the heat strain more intense.

The results of the investigations concerning the influence of environmental heat on the capacity for perceptive work show the necessity of measures to maintain and improve the state of vigilance during survey and control work at the control panels.

- 1203 Vaughan, H. G., Jr. The perceptual and physiologic significance of visual evoked responses recorded from the scalp in man. Vision Research, 1966, 6 (Supplement, Clinical Electroretinography), 203-223.

Evoked response studies in man linked with behavioral observations should provide valuable guidelines for the neurophysiologic analysis of the complex aspects of experience and behavior. Neurophysiology, despite recent advances, is tied to the study of neuronal processes a few milliseconds and a few synapses beyond the receptor. Perceptual, cognitive, and motor processes extend to several hundreds of milliseconds at the least. Data provided by evoked responses concerning the spatiotemporal distribution or "chronological localization" of neural processes associated with experience and behavior, may point to the appropriate areas for microelectrode studies.

- 1204 Vaughan, H. G., Jr. The relationship of brain activity to scalp recordings of event-related potentials. In E. Donchin & D. B. Lindsley (Eds.), Average evoked potentials: Methods, results and evaluations. Washington, DC: US Government Printing Office, 1969.

I have sketched the lines along which research on brain electrophysiology may provide data linking the cellular mechanisms underlying experience and behavior with gross electrical phenomena (ERPs) which may be observed directly during appropriate psychological experimentation. There are many who question the value of research which records macropotentials from the scalp of man or the brain of experimental animals. There is a current vogue for microphysiology which discounts the importance of the grosser neurophysiological phenomena. Nevertheless, there is a large gap to be traversed between the behavior of individual neurones in striate cortex and the perception of form. Large areas of brain, most of which remain unexplored by the microelectrode, must function in concert to produce the simplest visual experience. Where are these areas? When within the span of perception should we seek the relevant neural events? Some answers to these questions already emerge from the study of the ERP in man. In the visual modality, the VER has permitted us to define cortical events specifically related to geniculocalcarine input to striate cortex (Vaughan and Katzman, 1964; Vaughan and Gross, 1966); to brightness perception (Vaughan and Hull, 1965; Vaughan, 1966); to spectral sensitivity and other aspects of foveal vision (DeVoe et al., 1968); to the suppression of pattern vision during saccadic eye movements (Gross et al., 1967); to metacontrast suppression (Vaughan and Silverstein, 1968); and to motor responses to photic stimulation (Vaughan et al., 1965a, b). None of the direct quantitative correlations that have been possible in the human subject have been obtained, to my knowledge, with microelectrode recordings in experimental animals. Although feasible in principle, concurrent behavioral and physiological studies in animals are substantially more difficult than comparable studies in man. Human subjects may readily modify their behavior in response to instructions and may be studied repeatedly and extensively under a wide variety of conditions. Although animals may be trained to a wide variety of specific tasks, they possess neither the flexibility of the human subject nor his unique cognitive abilities. The latter, in addition to providing convenient means of experimental manipulation, offer the greatest challenge to an understanding of brain mechanisms. Although beyond our present experimental ken, the linguistic abilities of man must not be dismissed arbitrarily from the realm of behavioral neurophysiology. Similarly, the phenomena of consciousness, long banished from psychology, cannot be ignored in any attempt to comprehend the physiological basis of perception, cognition, and effect. The myth that only externally observable motor behavior can accurately reflect psychological processes has been demolished by observations of brain responses directly correlated with subjective perceptual variables.

- 1205 Vaughan, H. G., Jr., & Costa, L. D. Analysis of electroencephalographic correlates of human sensori-motor processes. Electroencephalography and Clinical Neurophysiology, 1968, 24, 288-289. (Abstract)

We have found that the slow negative shift preceding motor responses (the CNV or E wave) possesses a somato-topic localization consistent with its generation in motor cortex. Its properties suggest that the CNV is identical to the early portion of the motor potential and represents a cortical correlate of preparatory motor set.

- 1206 Vaughan, H. G., Jr., Costz, L. D., & Gilden, L. The functional relation of visual evoked response and reaction time to stimulus intensity. Vision Research, 1966, 6, 645-656.

Latency of the average visual evoked response (VER) and motor reaction time (RT) were studied as a function of stimulus intensity for brief photic stimuli subtending 4° and 1.5° of visual angle in two subjects. Both VER latency and RT showed an accelerating increase for each tenfold diminution in intensity down to the region of foveal threshold. Below foveal threshold no responses were obtained for the 1.5° stimuli; there was an inflexion in the VER latency and RT curve of responses to the 4° stimuli. Over the photopic range of intensities, VER latency and RT were closely described by power functions varying in exponent from -0.29 to -0.44 . The values for VER were -0.36 for the 4° stimuli and -0.40 for the 1.5° stimuli, which were significantly different ($p < 0.01$). Although latency of VER was the same for both subjects for each stimulus condition, RT showed a consistent difference between subjects of about 25 msec. RT is considered to be determined by at least two independent mechanisms. The first, retinal in location, follows a power function of intensity; the second is related to variability in efferent processes.

- 1207 Vaughan, H. G., Jr., Costa, L. D., Gilden, L., & Schimmel, H. Identification of sensory and motor components of cerebral activity in simple reaction-time tasks. Proceedings of the 73rd Annual Convention of the American Psychological Association, 1965, 179-180. (Abstract)

By comparing the absolute latency of the evoked response and the motor potential, the central delay of simple RT was estimated. This was found to vary from trial to trial between 20 and 60 msec. It is considered likely that factors such as attention and arousal level influenced specifically this component of RT.

Modality and intensity of stimulation appear to affect predominantly the afferent limb of the sensorimotor process, while efferent time depends upon the distance from cortex to responding muscle. In the present study the relative prominence of these components varied significantly as a function of stimulus and response conditions. Further application and refinement of these methods should permit definition of the spatial and temporal distribution of those electrical correlates of sensorimotor processes which are recordable from the convexity of the human brain.

- 1208 Vaughan, H. G., Jr., & Hull, R. C. Functional relation between stimulus intensity and photically evoked cerebral responses in man. Nature, 1965, 206, 720-722.

It is concluded that the expression $1/(t - t_0) = L^{0.93}$, where t_0 represents minimum latency of a given component of VER defined separately for photopic and scotopic vision, satisfactorily depicts the psychophysical relation between stimulus luminance and subjective brightness over the range within which reliable measurements of VER latency may be made.

- 1209 Vaughan, H. G., Jr., & Ritter, W. The sources of auditory evoked responses recorded from the human scalp. Electroencephalography and Clinical Neurophysiology, 1970, 28, 360-367.

The scalp distribution of auditory evoked responses (AERs) was studied in six normal subjects and in four patients who had undergone carotid angiography. The late (200 msec) component to regular stimulation showed a polarity inversion across a line overlying the Sylvian fissure, being positive above and negative below it. The observed distribution, when compared with that predicted from a multi-shell volume conductor model, was most consistent with dipole layer sources within the primary auditory projection cortex in the supratemporal plane. AERs to monaural stimuli were larger over the contralateral hemisphere, also supporting their specific origin. In contrast, the longer latency (300 msec) component appearing in AERs elicited by infrequent aperiodic stimuli possessed a different distribution consistent with its origin in parieto-temporal association cortex. It was possible to differentiate the myogenic post-auricular response, which possessed a quite circumscribed distribution, from the early AER components of intracranial origin whose distribution was similar to that of the 200 msec component.

- 1210 Vaughan, H. G., Jr., & Ritter, W. Physiologic approaches to the analysis of attention and performance. In S. Kornblum (Ed.), Attention and performance IV. New York & London: Academic Press, 1973.

By averaging the brain potentials related in time to stimuli and to motor responses, the timing and localization of neural processes underlying simple and complex sensorimotor sequences can be studied in man and in experimental animals. These "event-related potentials" (ERP) have been classified as sensory-evoked potentials (EP), motor potentials (MP), association-cortex potentials (ACP), and steady potential shifts (SPS), each with a characteristic temporal course and intracranial origin. The present limitation of definitive information on the quantitative relationship of ERP with underlying neuronal processes and with psychological variables must dictate great caution in relating them to complex psychological constructs such as attention. Physiological attempts to demonstrate modulation of sensory input associated with selective attention have been largely unsuccessful. This failure reflects an unduly constricted conceptual formulation of attention as well as inadequacies of earlier experimental approaches. Effective physiological approaches to the analysis of attention will require knowledge of the higher order cerebral mechanisms which underlie cognitive processes.

- 1211 Vaughn, A. O., & McDaniel, J. W. Electromyographic gradients during complex visual discrimination learning. Psychonomic Science, 1969, 16, 203-204.

Muscle activity levels during cognitive and motor performances recorded from various electrode placements have, in several studies, been shown to follow monotonically rising gradients throughout the experimental task. A complex match-to-sample visual discrimination task employed in this study demonstrated not only a tonic neuromuscular adjustment during performance, but also the occurrence of phasic shifts in activity corresponding to orienting reactions. These phasic responses tend to habituate rapidly with repetitive performance, and are rarely identified in overlearned Ss.

- 1212 Veen, W. J. Van, Knott, J. R., Peters, J. F., Miller, L. H., & Cohen, S. I. CNV shape differences and perceptual mode. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 327-328.

Previous studies using peak amplitude scores of the CNV have shown that this may vary as a function of length of i.s.i. (McAdams et al. 1969), quality of the imperative stimulus (Irwin et al. 1966), response called for (Rebert et al. 1967), and anxiety levels (Knott and Irwin 1968). However, in the present analysis, the shape of the CNV during the i.s.i. yields results obscured by single value scores. Shape appears to be a useful measure, and it should be included in future investigations of CNV and its determinants.

- 1213 Velden, M., & Juris, M. Perceptual performance as a function of intra-cycle cardiac activity. Psychophysiology, 1975, 12, 685-692.

The purpose of the experiment was to test the hypothesis of a systematic change in perceptual performance within a single cardiac cycle due to the activity of the baroreceptors in carotid sinus. As an index of perceptual performance the d_s -parameter from signal detection theory (TSD) was used. A 1000 Hz sine tone had to be detected in a background of white noise. Each of 4 subjects received on the average 4605 noise or noise plus tone stimuli distributed over 10 experimental sessions. When comparing performance during time intervals before and after baroreceptor activity onset no significant difference was found. Also, when tracing perceptual performance over the whole cardiac cycle in steps of 66, 100, and 200 msec, no systematic variation could be detected. For steps of 33 msec a rhythmic pulsation of perceptual performance of about 8 Hz appeared. An influence of electrical activity of the brain on perceptual performance was postulated. This activity would have to be time-locked to carotid sinus baroreceptor activity.

- 1214 Verschoor, A. M., & van Wieringen, P. C. Vigilance performance and skin conductance. Acta Psychologica, 1970, 33, 394-401.

The relation is explored between vigilance performance and skin conductance level. Attention is made between good and bad detectors. During the watch, performance and skin conductance of the good detectors remain constant; the bad detectors show a decrement on both variables. A second experiment is reported with a more complicated signal presentation (two types of signals). In comparison with the simple detection task (one type of signals) there is no difference in skin conductance, while detection and RT show less decrement in the more complicated task.

- 1215 Vettes, B. Evaluation de la charge de travail des pilotes d'helicopteres enregistrements en vol de la frequence et de la variabilite du rythme cardiaque. [Evaluation of helicopter pilot workload by in flight recording of heart rate frequency and variability.] In K. E. Klein (Ed.), Studies on pilot workload. AGARD Conference Preprint, No. 217, 1977. (Available from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151)

Cardiac variability appears to be a better criterion than instantaneous cardiac frequency; however, it is not yet possible to affirm a close relationship between these parameters and flight work load.

- 1216 Vogel, W., Broverman, D. M., & Klaiber, E. L. EEG and mental abilities. Electroencephalography and Clinical Neurophysiology, 1968, 24, 166-175.

EEGs were recorded during rest and during periods of mental effort in two samples of normal young adult males. Relationships were investigated between EEG slow waves, alpha index, alpha frequency, beta index, and beta frequency, and three separate indices of mental ability: (1) general level of mental ability; (2) the Automatization Cognitive Style, defined as greater ability (strong automatization) or lesser ability (weak automatization) to perform simple repetitive tasks than expected from the individual's general level of mental ability; and (3) performance on intellectual tasks while the EEG was being recorded. Principal findings were that (1) slow waves and slow alpha frequencies were positively associated both with automatization ability and with efficient cognitive performance under conditions of mental effort; and (2) Automatization Cognitive Style was inversely related to beta index during periods of mental effort. These results were interpreted as providing evidence of stable and meaningful relationships between mental abilities and neurophysiological events as reflected in the EEG.

- 1217 Volavka, J., Matousek, M., & Roubicek, J. Mental arithmetic and eye opening: An EEG frequency analysis and GSR study. Electroencephalography and Clinical Neurophysiology, 1967, 22, 174-176.

1. Twelve healthy subjects were examined. EEG and GSR were taken when the subjects were resting with their eyes closed (C), resting with their eyes open (O), performing mental arithmetic with their eyes closed (A), and performing mental arithmetic with their eyes closed and promised financial reward (M).

2. The number of GSRs in condition M was significantly higher than in any other condition.

3. Frequency analysis was made of the EEG of the right parieto-temporal region and the number of GSRs was ascertained according to precisely specified criteria.

4. In condition O relative quantities were on the average lower in all frequency bands than in conditions A and M.

5. In conditions O, A and M theta and alpha activities registered a lower level than in condition C.

6. In condition O beta activity decreased, while increasing on the average in conditions A and M.

7. Compared with conditions C and O, the variability of beta activity in conditions M and A was lower.

8. Frequency analysis did not disclose any significant difference between conditions A and M.

9. The results indicate that beta activity (both its amount and variability) is more closely related to the general level of activation than are the brain waves in any other frequency band under study.

W

- 1210 Wallerstein, H. An electromyographic study of attentive listening. Canadian Journal of Psychology, 1954, 8, 228-238.

In an experiment designed to investigate muscular activity during sustained attention, two groups of subjects were requested to listen to three successive presentations of a recorded detective story and philosophical essay.

Results showed rising gradients of tension from forehead and chin throughout the course of listening. Listening to the story tended to produce increases of greater magnitude than did listening to the essay. Forearm muscles failed to show any clear variations during listening.

The rising gradients of muscle tension may be associated with increasing comprehension or organization of incoming verbal material - organization which may take place during attentive listening.

- 1210 Walsh, E. G. 'Visual attention' and the α -rhythm. Journal of Physiology, 1953, 120, 155-159.

1. The ability to recognize patterns consisting of 1-10 luminous dots presented tachistoscopically did not appear to depend on the amplitude of the α -rhythm.

2. The amplitude of the α -rhythm when the subject concentrated on counting clicks did not differ significantly from the amplitude when he concentrated on counting flashes.

3. The term 'attention' is ambiguous. The results do not lend support to the 'visual attention' theory.

- 1220 Walter, G. F., & Porges, S. W. Heart rate and respiratory responses as a function of task difficulty: The use of discriminant analysis in the selection of psychologically sensitive physiological responses. Psychophysiology, 1976, 13, 563-571.

The relationship between physiological response patterns and task difficulty was investigated by evaluating heart rate and respiratory responses during a choice reaction time task with three levels of task difficulty. The data fit a two-component model of attention containing reactive and sustained responses. There were two reactive responses: An immediate deceleration which was independent of task manipulation; and a short latency response, monotonically paralleling task difficulty, which was characterized by acceleration and an increase in heart rate variability. The sustained component exhibited task dependent deceleration and a generalized reduction in heart rate variability and respiration amplitude variability. A stepwise discriminant analysis was performed on the task conditions using physiological responses to determine responses sensitive to task demands. Physiological response patterns were monotonically ordered as a function of task difficulty, suggesting that this technique may have advantages for determining physiological responses most sensitive to psychological manipulation.

1221 Walter, W. G. The contingent negative variation: An electrocortical sign of significant association in the human brain. Science, 1964, 146, 434. (Abstract)

This Contingent Negative Variation (CNV) reflects the probability of signal association as estimated by the subject and is independent of stimulus amplitude or energy. It is particularly large and consistent when the stimuli are purely semantic, provided that they are meaningful to the subject and that some decision or action is required.

1222 Walter, W. G. The convergence and interaction of visual, auditory, and tactile responses in human nonspecific cortex. Annals of the New York Academy of Sciences, 1964, 112, 320-361.

The eight or so properties of evoked responses in nonspecific cortex described above provide what may be called an operational specification for the input circuits of a learning machine. They may be considered in two groups. The first includes the four features which relate to the preliminary operations on all afferent signals irrespective of their context: Dispersive Convergence, Modality Signature, Idiodromic Projection, and Differentiation. Since these mechanisms are concerned with the extraction of meaning from sensory stimuli, these preliminary processes may be thought of in linguistic terms as specifying the orthography of the cerebral code, the established procedure and accepted abbreviations for signals from all sources. The second group of properties, Habituation, Contingent Amplification, Contingent Attenuation, Unconditional Restoration, specify the conjugation and syntax of signals according to their context and destination.

1223 Walter, W. G. Slow potential waves in the human brain associated with expectancy, attention, and decision. Archiv fur Psychiatrie und Zeitschrift fur die Gesamte Neurologie, 1964, 206, 309-322.

1. Stimuli in any modality evoke responses over wide regions of frontal non-specific human cortex.

2. When identical stimuli are monotonously repeated these responses diminish irregularly and finally disappear.

3. When the significance of the association between conditional and imperative stimuli is diluted by presenting a proportion of unreinforced conditional stimuli (equivocation) the E-wave is diminished accordingly and in normal adults vanishes when the probability of association falls to about 0.5.

4. Stimuli involving no energy transfer to the subject but with a high information content evoke E-waves as long as the subject considers the signals interesting and important, whether they are isolated, imperative or conditional.

5. The E-wave seems to indicate the subjective significance assigned by a particular person to the signal association or "Gestalt" used for the experiment. The significance thus determined includes the need for recognition or decision, and involves social as well as physiological influences.

1224 Walter, W. G. Brain mechanisms and perception. British Journal of Physiological Optics. 1965, 22, 1-9.

Considered in terms of perception, these observations suggest several conjectures. First, the importance of something like action by the percipient is emphasised. We can only say 'something like' because, although the simplest situation and the clearest results are seen when the subject actually performs a motor act, such as pressing a button or speaking, the E-Wave grows and declines with variations in what seem to be purely mental activities, as when we work with pictures. We must recall that we have no way of telling whether the subject has 'perceived' the picture unless he performs some action, but we can foretell from the form of his brain responses whether he will report perception at the end of the run. We can even estimate the accuracy of his perception if this is an essential part of the situation, or his intrinsic interest in the figure if there is no specific problem to be solved. Second, in all the experiments described, the establishment of a percept seems to depend directly on the statistical relation of the components. This is illustrated most clearly perhaps in clinical studies where the patient is unable to manage living in the outside world, in such people the statistical computer in the brain seems to be badly programmed, so to say. Associations which are highly significant and helpful to normal people evoke no interaction of brain responses in such patients, they are preoccupied with fear or compulsive thoughts and fail to perceive what seem to most of us quite obvious relations. The third factor, which raises many exciting possibilities, is the enormous power of what I have called 'social influences' in the establishment of brain interactions. Here again, this is most evident in children and disturbed patients, but even in healthy young adults a single phrase or gesture may be more effective in the consolidation or dissolution of an E-Wave than 20 or 30 direct experiences. This is only common sense, of course - education involves just this combination of instruction, explanation, reassurance and admonition with the provision of suitably contrived direct experience - but the recognition of such processes in the brain should open up an entirely new realm of exploration.

1225 Walter, W. G. Brain responses to semantic stimuli. Journal of Psychosomatic Research. 1965, 9, 51-61.

These observations confirm that the responses evoked in the anterior brain regions by sensory stimuli are dependent on the subjective significance of the experience as a whole rather than on the intensity of the individual stimuli. The technique by which these responses can be extracted from the background activity of the E.E.G. imposes some limitations on the procedure since the operation of the response computer must be synchronised electrically with the presentation of the stimuli. Furthermore, the computation of an average depends on the collection and storage of several responses and the features of the individual trials are therefore effaced just as the random components are. For this reason these experiments were designed so as to provide situations in which twelve exposures could be made in a given category such as "all figures identical" or "figures varied". The clear differences seen between the responses in such conditions show that the physiological processes are influenced by the "set" or attitude of the subject as well as by the selective information contained in the objective presentations.

- 1220 Walter, W. G. Effects on anterior brain responses of an expected association between stimuli. Journal of Psychosomatic Research, 1965, 9, 45-49.

The neurological mechanisms involved in the contingent habituation of the responses in anterior cortex to associated stimuli were investigated. Using direct coupling and equipotential scalp electrodes, electronic averages were made of E.E.G. records. It was shown that the apparent attenuation of the negative variation in the response to the second stimulus was a submergence of this response in a slow negative wave of expectancy between the two stimuli. It is concluded that such expectancy waves occur in anterior cortex between all associated stimuli when contingent habituation is present.

- 1227 Walter, W. G. Electrophysiologic contributions to psychiatric therapy. Current Psychiatric Therapies, 1966, 6, 13-25.

A portion of this paper reviews the relation of CNV to a number of cognitive processes in normal subjects.

- 1228 Walter, W. G. Expectancy waves and intention waves in the human brain and their application to the direct cerebral control of machines. Electroencephalography and Clinical Neurophysiology, 1966, 21, 616. (Abstract)

The effect first described as the Contingent Negative Variation or CNV and sometimes known as the Expectancy Wave can be recorded consistently from all normal adult subjects. The mental state in which the E wave develops is compounded of readiness, motivation, attention and expectancy and the potential rise is terminated by recognition, decision, action and consummation. The signals needed to initiate and terminate the E wave can be purely semantic, in the form of words or pictures, and the engagement of the subject need involve only a mental change.

Averaging with suitable time-delays from tape records has confirmed the observation of Kornhuber that a similar Readiness or Intention Wave appears a second or so before a spontaneous voluntary decision or action, but this also need not involve a physical movement. When the voluntary act is arranged to provide an experience (such as the appearance of an interesting picture) the Intention Wave persists through the action until the picture appears. The Intention Wave, suitably amplified and filtered, can then be made to trigger the projector and computer directly so that the subject has the desired experience before any action has been taken. Similarly, an Expectancy Wave can be made to initiate or arrest an imperative stimulus directly, thus by-passing the operant effector system.

1220 Walter, W. G. Electrical signs of association, expectancy and decision in the human brain. Electroencephalography and Clinical Neurophysiology, 1967, Supplement 25, 258-263.

In normal subjects sensory signals reach frontal cortex by a process of "idiodromic projection" to establish a "dispersive convergence".

Responses evoked by monotonous stimuli decline steadily unless the character of the stimulus is changed in some way.

When paired stimuli are presented and a normal subject is asked to respond in some way to the second stimulus, the primary responses to the first stimulus are augmented and a new electrical effect appears in the brain during the period between the first ("conditional" or warning) stimulus and the second or "imperative" one.

This new effect has been called the contingent negative variation (CNV) or expectancy wave since it reflects the extent to which the subject expects the association between signals to be significant and intends to respond to them.

In normal subjects the CNV is quite constant but follows variations in mood and attitude; it terminates abruptly when the decision or action is completed.

In conditions of acute or chronic stress, including equivocation in normal subjects or anxiety states, obsessional neurosis, psychopathy or hysteria in patients, the development of the CNV is correlated with the type and degree of mental disorder. Patients who fail to establish relevant associations show little or no signs of a CNV. In cases of anxiety the CNV can be promoted by reassurance and exhortation, but this is not effective in psychopathic states. In compulsive-obsessional patients the CNV tends to persist far beyond the moment of action or decision. Such observations suggest that absence of the CNV can be due to endogenous distraction. In cases of chronic anxiety, relief by intracerebral selective coagulation is accompanied by re-appearance of the CNV and reduction in autonomic excitement.

1230 Walter, W. G. Slow potential changes in the human brain associated with expectancy, decision and intention. Electroencephalography and Clinical Neurophysiology, 1967, Supplement 26, 123-130.

The Contingent Negative Variation or Expectancy Wave appears in normal people whenever a warning or conditional stimulus is followed by an event which is expected to involve an action or decision. This event may be a second imperative stimulus or a moment when a decision must be taken. Neither external sensory stimuli nor overt motor acts are essential for the appearance of an E wave. The potential difference arises in the superficial layers of the pre-motor frontal cortex. It is reduced by equivocation and boredom, increased by exhortation and sometimes by competition. The E wave can develop in 0.5 sec and persist for 20 sec if the subject is highly motivated. It is not dependent on stimulus modality or intensity, and may be readily evoked by semantic, pictorial or verbal signals involving no energy exchange.

The Bereitschaftspotential or Intention Wave of Kornhuber and Deecke seems to be similar in many respects to the E wave, arising from congruent regions about 1 sec before a voluntary action but persisting until the result of the action expected by the subject has been achieved.

Both the E wave and the I wave can be used to operate computing and stimulating machinery directly through judicious filters and trigger circuits. In this way a subject can learn to obtain a desired experience at will, without physical action.

The properties of these slow potential changes suggest that they may reflect the mechanism whereby cerebral responses to sensory signals are integrated, correlated with internal memory stores and translated into relevant decisions or actions.

1231 Walter, W. G. The contingent negative variation: An electro-cortical sign of sensori-motor reflex association in man. In E. A. Asratyan (Ed.), Progress in brain research. Vol. 22 Brain reflexes. Amsterdam: Elsevier, 1968.

(1) When paired stimuli separated by about 1 sec, in any combination of modalities, are presented to a human subject who intends to act in some way in response to the second, a slow surface-negative wave appears in frontal cortex.

(2) This effect has been designated the Contingent Negative Variation (CNV); it reflects the probability of association of the stimuli and the intention to respond on the part of the subject.

(3) Extinction by withdrawal of the unconditional or 'imperative' stimulus results in a slow decline of the CNV to zero over about 20 trials.

(4) When the subject is warned beforehand that the imperative stimuli are to be withdrawn the CNV disappears at once.

(5) Dilution of the probability of association by partial reinforcement ('equivocation') produces a decline in the CNV which follows the subjective probability as estimated by the subject.

(6) If the subject decides not to act on the imperative stimulus the CNV disappears at once.

(7) A purely mental response such as estimating a time interval or making a decision is enough to establish a CNV provided that the subject is interested and involved.

(8) A 'negative' stimulus such as the cessation of a tone and a 'negative' response such as stopping pressure on a button are also adequate for the development of a CNV.

(9) The CNV is considered as the major outward sign of frontal dendritic depolarisation in any situation in which some cerebral action can be accelerated and simplified by conditional learning.

- 1232 Walter, W. G. Can 'attention' be defined in physiological terms? In C. R. Evans & T. B. Mulholland (Eds.), Attention in neurophysiology. London: Butterworths, 1969.

Returning to the general question of whether 'attention' is a concept which can be defined in physiological terms or is a semantic dragon, we can see one possibility at least. If we start by considering what can actually be observed and measured in physiological experiments, the diversity of brain responses, although large, is not infinite. We can identify a finite set of response patterns, each related to a relative parameter of the sensory signals. Unfortunately, the specification of this set must include regional characteristics as well as voltage-time dimensions so that a single measure will rarely be adequate.

- 1233 Walter, W. G., Cooper, R., Aldridge, V. J., McCallum, W. C., & Winter, A. L. Contingent negative variation: An electric sign of sensorimotor association and expectancy in the human brain. Nature, 1964, 203, 380-384.

A series of experiments has been performed to investigate the effects on these components of varying the probability of association between the conditional and imperative stimuli, and also the influence of variations in effector participation and mental attitude. The effects of direct suggestion under hypnosis have already been described.

The non-specific responses to conditional stimuli usually consist of three main components: a brief surface positive wave, a brief surface negative wave superimposed on this, and a much more prolonged surface negative component which may last several seconds, particularly in children. The details of the first two components depend somewhat on the modality, the responses to auditory stimuli being usually larger, simpler and more consistent than those to visual or tactile stimuli. The features which seem most closely related to the contingency of the situation and to the attitude of the subject are the prolonged secondary negative waves and their interaction with the subsequent responses to imperative stimuli.

- 1234 Walter, W. G., Cooper, R., Crow, H. J., McCallum, W. C., Warren, W. J., Aldridge, V. J., Van Leeuwen, W. S., & Kamp, A. Contingent negative variation and evoked responses recorded by radio-telemetry in free-ranging subjects. Electroencephalography and Clinical Neurophysiology, 1967, 23, 197-206.

1. The initial responses and CNV during the reception of paired auditory signals were similar to those seen with direct connection, provided that the subjects were engaged in some task related to the signals. The CNV was attenuated during exercise or conversation only while the subject was inattentive to the signals.

2. The amplitude of the intracerebral responses to the conditional and imperative stimuli in the patients with implanted electrodes was reduced when the scalp CNV was attenuated by isolation or distraction.

3. During the performance of fairly complex tasks following the auditory signals, the CNV terminated only at the completion of the task, not at the moment of muscular effort.

4. The radio-control link was also used to instruct an experimenter when to toss a ball to a subject or to feint. In this situation also the CNV developed only when the subject was sure the ball was in the air and terminated when it was caught.

5. These observations suggest that the interactions of evoked responses and CNV seen in laboratory conditions also accompany normal activity and the performance of everyday tasks.

- 1236 Warren, L. R., & Harris, L. J. Arousal and memory: Phasic measures of arousal in a free recall task. Acta Psychologica, 1975, 39, 303-310.

EEG alpha activity and skin potential were monitored during word presentation in a single trial free recall task. Phasic changes in EEG alpha and skin potential, co-occurring with word onset, were positively related to recall at an immediate retention interval (2 min) but not after a delay (45 min). The results were interpreted as supporting the extension of Routtenberg's (1968) two-arousal system hypothesis to human memory. Arousal was viewed as affecting memory during the attribute encoding stage of memory storage.

- 1236 Wartna, G. F., Danev, S. G., & Bink, B. Heart rate variability and mental load. A comparison of different scoring methods. Pflügers Archiv, 1971, 328, 262-263. (Abstract)

As part of a larger psychophysiological study on the relative contribution by each of several aspects of mental work to the functional load of an individual, an experiment was conducted in which the relation was studied between loading of the identification mechanism and functioning of the cardiovascular system. Ten Ss performed an eight choice reaction task under two experimental conditions: they had to respond either in a compatible way or in a random manner. In both conditions the motor component of the task was the same.

The results turned out to be in accordance with the hypothesis that loading of the identification mechanism induces a change in some aspects of the cardiovascular functioning irrespective of the physical load caused by the motor part of the task. The variability of the heart rate as expressed by the standard deviation of the R-R intervals, is suppressed by 9% ($p < 0.05$), while the irregularity as expressed by the number of waves in the cardiogram increases by 15% ($p < 0.01$). The level of heart rate as well as the HR variability as expressed by measures based on differences between successive R-R intervals remain the same. The conclusion is drawn that as long as the specific control mechanisms underlying specific changes in certain aspects of the cardiovascular functioning are unknown it is advisable to use at least one representative of each of the above mentioned four groups of parameters in this kind of studies.

- 1237 Wartna, G. F., & Dirken, J. M. Vigilance tasks and level of activation: Theoretical backgrounds and an orientational investigation. (in Flemish) Leiden the Netherlands: Netherlands Institute for Preventive Medicine, TNO, 1968.

The role of the human operator in complex man-machine systems is described in terms of system design theory. Attention is given to the vigilance aspects of tasks in modern industry. Several theories of vigilance are reviewed. The physiological and psychological implications of a theory of activation are treated. Vigilance behaviour was studied in a psychophysiological experiment. Subjects performed a vigilance task under five different conditions: heat, noise, knowledge of results, special instruction and a control condition. Cardiovascular reactions were measured during task performance. In the final analysis neither performance nor cardiovascular parameters showed significant differences between conditions. The subjects turned out to be the most important source of variation on these parameters.

- 1238 Waszak, M., & Obrist, W. D. Relationship of slow potential changes to response speed and motivation in man. Electroencephalography and Clinical Neurophysiology, 1969, 27, 113-120.

1. Within subjects, the fastest reaction times were preceded by CNVs of significantly larger amplitude than were the slowest responses. A comparable relationship was not found between subjects.

2. Reaction times were shorter, and the negative evoked potential to the warning stimulus had a significantly greater amplitude when the subjects were in a state of high motivation than when they were urged to relax. Other potentials, including the CNV, did not show this difference between motivational conditions.

3. Trials in which subjects were required to respond were followed by a broad positive wave of moderate amplitude, whereas trials in which they withheld a response were followed by a short positive wave of much greater amplitude. The height of both potentials was significantly correlated with mean reaction time across subjects.

1230 Waters, W. F., McDonald, D. G., & Koresko, R. L. Habituation of the orienting response: A gating mechanism subserving selective attention. *Psychophysiology*, 1977, 14, 86-87. (Abstract)

The purpose of this investigation was to determine whether performance on an attention-demanding task laced with distracting stimuli would be enhanced if the task were preceded by habituation of the orienting response to the distractors. The task was a series of simple mathematical problems to be solved from immediate memory; the distractors consisted of a random sequence of numbers and mathematical signs (+, -, =). All stimuli were presented via a prerecorded audio tape, the problem by a male voice and the distractors by a female voice. Ninety-seven male undergraduate subjects were sequentially assigned to one of four conditions: 1) problems with distractors; 2) problems with distractors, preceded by distractors alone; 3) problems with distractors, preceded by a series of control tones; 4) problems without distractors, preceded either by distractors or by tones. Results clearly indicated that prior habituation of the orienting response to the distractors was followed by significantly improved performance relative to 1) the no-prior-habituation condition, and 2) the prior-habituation-to-tones condition. One of the psychophysiological measures employed, heart rate response, indicated that those subjects who showed the greatest habituation to the distractors also performed significantly better in solving the mathematical problems. The results are interpreted as supporting the view that selective attention consists of at least two processes: 1) sensitization of orienting responses to salient stimuli, and 2) habituation of orienting responses to irrelevant stimuli.

1240 Webb, R. A. The physiological concomitants of reaction time performance as a function of preparatory interval and preparatory interval series (Doctoral dissertation, University of North Carolina at Chapel Hill, 1968). *Dissertation Abstracts*, 1969, 29, 4879B. (University Microfilms No. 69-10, 212)

Highly significant deceleration of heart rate, inhibition of EMG, and cessation of eye movements and blinks were found in the preparatory intervals (PI) just prior to the S's response. Changes in all measures were highly related to each other. In addition there was evidence that each measure was concomitant with reaction time performance. The degrees of concomitance were not equal, however, when estimated by different methods of analysis. All measures tended to demonstrate similar patterns as a function of group and PI. Furthermore, an analysis of each S's best and worst reaction time trials demonstrated that all measures tended to differentiate good from poor performance within individual Ss. An across S correlational analysis indicated, however, that the across S concomitance was not as high and accounted for only a small portion of the variance. The appropriateness of the various analyses was discussed.

The study did not provide a critical test of the Lacey and Obrist models because at the only point at which the manipulations eliminated the cardiac deceleration the reactivity on the somatic measures was also greatly reduced. This finding does tend to lend credence to the Obrist model. Several features of the data suggested that neither the Obrist nor Lacey models were applicable at the 2 sec PI in the two regular groups. Finally, the results suggested a method for arranging a critical test of the Lacey and Obrist models by means of a drug study.

- 1241 Webb, R. A., & Obrist, P. A. The physiological concomitants of reaction time performance as a function of preparatory interval and preparatory interval series. Psychophysiology, 1970, 6, 389-403.

The cardiac deceleration which occurs during the preparatory interval (PI) of a reaction time (RT) task was examined with reference to a facilitory feedback model in contrast with a model which viewed the response as part of a somatic inhibitory response. Sixty-three male Ss were run in three independent groups in an RT study. Two groups received 96 trials (divided into blocks of 24) with PIs of 2, 4, 8, and 16 sec presented in a regular series counterbalanced for order. The third group received the same number of trials of each PI in a restricted random order. Heart rate (HR), chin electromyograph (EMG), eye blinks, and eye movements were recorded as dependent variables.

Results indicated an orderly, time-locked decline in EMG, eye blinks and movements, which was closely concomitant with a deceleration in HR during the PI. With some exceptions, the various measures demonstrated similar functional relationships with Group and PI variables. The results failed to differentiate between the feedback and somatic inhibitory models because the only combination of variables which eliminated HR deceleration also eliminated the inhibition of the somatic measures. This fact is consistent with the somatic inhibitory model, but is neutral with respect to the feedback model. Different statistical methods for examining the cardiac-somatic concomitance were discussed.

- 1242 Webb, R., Williams, F., & Minifie, F. D. Effects of verbal decision behavior upon respiration during speech production. Journal of Speech and Hearing Research, 1967, 10, 56.

This study tests the hypothesis that respiratory activity during induced silent pausing decreases when the speaker is faced with increased demands upon decision behavior. Two conditions, reasoned to impose restrictions upon the hypothesis, were manipulated in addition to the variable of decision demand: (1) the grammatical environment in which silent pausing was induced, and (2) the level of breath supply at the moment of pause inducement. Continuous measures of breathing were obtained by use of a respirometer while subjects were performing an oral reading task which involved decision-making during a two-second induced silence. The breathing measures were subsequently divided into eight quarter-second intervals for analysis. Results indicated that the only outcome supportive of the hypothesis was in the last half-second of the "hold" period in the case of within phrase environments. Such results were independent of the breath supply conditions. Further analyses indicated that lower mean values of air moved in the increased decision demand condition were a function of fewer subjects breathing, rather than of subjects breathing less.

- 1243 Werts, T. C., & Lang, P. J. The effects of eye fixation and stimulus and response location on the contingent negative variation (CNV). Biological Psychology, 1973, 1, 1-19.

Vertex and parietal cortical slow waves and horizontal and vertical eye movement were recorded from 16 male subjects. Each subject was run in four constant-foreperiod reaction time conditions, in which the location of the auditory stimulus (speaker position above or below; to the subject's left or right) and the presence or absence of an eye focusing light was varied. Eye movements were unrelated to stimulus location, but were correlated with the position of the response key. Eye fixation resulted in reduced eye movement; however, it markedly reduced the cortical potential (CNV), unless the fixation light also served as the imperative stimulus. The relationship of eyeblinks and eye movement to the CNV was shown to be complex, and no method provided perfect correction for this artifact. The study also demonstrated the biphasic character of the cortical potential during the RT foreperiod. An early negative phase is apparently related to signal stimulus orientation, and habituates over trials; a separate, later negativity, appearing just before the imperative stimulus, appears to be the true CNV.

- 1244 Wegmann, H. M., Klein, K. E., & Kuklinski, P. Störungen der tagesrhythmik nach zwei transatlantikflügen in rascher folge. [Changes in the 24-hour rhythm after two transatlantic flights in rapid sequence.] In Aktuelle Forschungsarbeiten aus dem Institut für Flugmedizin. [Current scientific papers from the aerospace medical institute.] (DLR-FB 73-15). Porz, West Germany: Aerospace Medical Institute, January 1973.

The effects of two transatlantic flights in rapid sequence upon the 24-hour rhythm of body functions and performance were studied in 8 male subjects. Flights were performed as outgoing and return flight between Frankfurt and Chicago with a time shift of 6 hours and a stopover time of 26 hours. The results and their operational significance for the flying personnel are discussed.

- 1245 Weinberg, H. The contingent negative variation: Its relation to feedback and expectant attention. Electroencephalography and Clinical Neurophysiology, 1973, Supplement 33, 219-228.

A paradigm for the study of slow waves was used in which an attempt was made to differentiate between effects attributable to expectant attention and those attributable to intention to respond. This was accomplished by making a discriminative response which occurred at S₂ contingent on information carried in S₁, and by giving feed-back information about accuracy of the response by means of a third stimulus, S₃. Each of the stimuli occurred successively, separated by approximately 1 sec. Two variations of this method were used: (1) a procedure in which the third stimulus was always present before instructions as to its meaning; and (2) a procedure in which the third stimulus was absent, after which was added the third stimulus and instructions about its meaning.

The data indicated that surface negativity was sustained during periods when the Ss were waiting for feed-back although there was no intention to respond. This occurred even when there were no instructions as to the meaning of the stimulus when S characteristically attempted to decode its meaning. The results were interpreted to suggest that negativity was sustained during periods of unconfounded expectant attention.

It was also suggested that sustained negativity sometimes seen in cases of behavior pathology, when a standard CNV paradigm is used, may be attributable to the attempt of subjects to continue processing information relative to the response after S₂ and the response has occurred.

- 1246 Weinberg, H., Michelewski, H., & Koopman, R. The 'form' of the CNV: The relative effect of information in the ready and imperative stimuli. (Abstract) In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

Twenty normal subjects were tested in a CNV paradigm in which a warning signal (S_1) was followed after an i.s.i. of 1.5 sec by an imperative signal (S_2). The response, made to S_2 , was contingent upon information presented in either S_1 or S_2 . When the discriminative information determining the response occurred at S_1 the CNV assumed a form which was significantly different from that observed when it occurred at S_2 . When the information was given at S_1 the CNV tended to show a ramp-like negative rise having its peak immediately prior to S_2 . When the information was given at S_2 there tended to be a rapid early rise of the CNV followed by a slow decline in negativity. Both wave forms differed from that obtained in a 'standard' CNV situation where no discrimination was involved.

The findings suggest that the CNV may be the result of the interaction of two types of information processing. One type involves time estimation, which is positively related to CNV amplitude. The second type, which is inversely related to CNV magnitude, is information processing relative to the specific nature of response performance.

- 1247 Weinrich, L. Signalerkennung als Funktion des psychophysiologischen Aktivitätszustandes. [Signal detection as a function of psychophysiological activity.] Zeitschrift für Psychologie, 1968, 175, 217-231.

Three different psychological activities were defined by their EEG patterns. Norms and validity were tested in various vigilance tests. Fewest errors and easiest detection occurred in nonrelaxed, passive waking states with dominantly synchronic EEG alpha activity. In this state the parameters for sensory components and for decision criterion are at maximum. Classification variables decrease with extreme activation in waking states.

- 1248 Weiser, P. C. Interrelationships of the motor and metabolic support systems during work and fatigue. In E. Simonson & P. C. Weiser (Eds.), Psychological aspects and physiological correlates of work and fatigue. Springfield, Ill.: C. C. Thomas, 1976.

Fatigue at submaximal work levels relative to max Vo_2 develops much more slowly but has some of the same types of impairments seen in maximal work. Above 50% max Vo_2 , these are 1. reduced contraction and/or ATP regeneration with motor units derecruiting and 2. altered respiratory activity with hyperventilation, as well as 3. altered cardiovascular functions suggestive of cardiac decompensation and 4. decreased blood glucose level with altered CNS functioning. Commonly, symptoms such as "tired muscles," "heavy legs," and "uncoordinated" are reported. With tasks requiring less than 50% max Vo_2 and especially below 30% max Vo_2 , the factors giving rise to fatigue become much the same as those for sedentary work. It must be noted that at a given absolute work load, those individuals with lower max Vo_2 must be working at a higher relative work intensity.

Prolonged sedentary work can be considered as that which requires less than 15% max $\dot{V}O_2$ and which leads to a situation in which fatigue must be separated from monotony, if it can be. Thus, decreased capacity to do sedentary work commences with altered activity of the reticular activating system, etc., and with the disorganization of information processing.

It is hoped that this chapter sets the physiological framework for the following discussion of the roles that perception and information processing, reflexes and motor coordination, motivation, and subjective feeling states take in the development of fatigue in various work situations.

1240 Weitzman, E. D., & Kremen, H. Auditory evoked responses during different stages of sleep in man. Electroencephalography and Clinical Neurophysiology, 1965, 18, 65-70.

Responses to auditory stimuli can be recorded from the scalp of man in all stages of sleep. At the vertex, the mean peak latency of the first positive deflection (P_1) occurs at 50 msec after stimulation; N_1 at 100 msec; P_2 at 175 msec; N_2 at 325 msec; and P_3 at 800 msec. The amplitude and latency of the components of longer latency (N_2 and P_3) increase during stages 2 through 4 sleep. The amplitude of the summed auditory evoked responses during the REM stage is considerably smaller than in the other stages and generally is of similar configuration to that of the awake state. Our results support the concept that the auditory evoked response during sleep represents summed K complexes.

1250 Welch, A. J., Richardson, P. C., Thomas, C. W., & Aldredge, J. M. Bandwidth reduction of sleep information (Tech. report No. 92). Austin, Texas: Bio-Medical Engineering Research Laboratory, University of Texas, July 1970. (NTIS No. AD 718125)

Many important space and military missions require maximal alertness which is dependent on adequate amounts of rest and sleep. In order to study sleep-wakefulness patterns in realistic space and military situations, it is necessary to monitor the level of arousal with simplified reliable band-limited devices.

The limited time bandwidth available for the transmission of sleep information necessitates the development of a technique for data compression. This report describes the possibility of extracting sleep information from heart rate data. Several features of heart rate which contain sleep information are computed and analysis of variance is used to indicate the suitability of these measures in the pattern recognition of sleep stages from heart rate data.

1201 Welford, A. T. Arousal, channel-capacity and decision. Nature, 1962, 194, 365-366.

Three possible results of increased activation appear to need consideration in terms of this approach:

(1) A true improvement of discrimination will occur only if there is an increase in the distance, measured in standard-deviation units, between the peaks of the two distributions - in other words, if facilitory effects raise the signal strength more than the noise-level and thus enhance signal-to-noise ratio strength. If noise rose more than signal strength, as might happen at very high activation-levels, the distributions would be widened and their peaks moved to higher activation-levels; but both would be moved by the same amount so that the distance between them in standard-deviation units would be reduced and discrimination would fall.

(2) Apparent changes of sensory threshold might nevertheless result either from an increase of noise alone or from a proportionate rise of both signal and noise together. In both cases the distributions would be shifted to higher levels and thus, if the cut-off point remained the same, a higher proportion of signals would be detected. There would, however, also be a rise in the number of false positives - moderate with an increase of both signal and noise together, severe with an increase of noise alone. The same type of result would, of course, be produced if the cut-off point moved to a lower level. This might well occur as an additional effect of increased activation since the cut-off point must represent the threshold of some other mechanism in the brain and this would almost certainly tend to be affected by any general increase of ambient brain activity.

(3) If, however, the subject tried to reduce false positives by moving the cut-off point to a higher level, the proportion of omissions and thus the apparent sensory threshold might either rise or remain unchanged.

It is not easy to distinguish between these various alternatives, but it seems logically possible to do so if psychophysical measurements are made in such a way that omissions and false positives can be counted separately and the results compared with an independent, preferably physiological, measure of activation.

- 1202 Welford, A. T. Fatigue and monotony. In O. Edholm & A. Bacharach (Eds.), Physiology of human survival. London: Academic Press, 1965.

At the present time four points seem to stand out. First, fatigue is now clearly recognised as a blanket term covering a variety of processes in many different bodily mechanisms. These are, to a much greater extent than had previously been realised, neural mechanisms in the brain. Much of the confusion that has arisen hitherto in discussions on fatigue has been due to the fact that closely similar phenomena in the areas of slowing, blocking, disorganization of performance and phases of hyperactivity can have widely different causes. We cannot distinguish between these by studying the crude phenomena alone, but need to gather ancillary evidence and to consider the precise nature of the tasks being performed. Secondly, progress has been made in drawing a distinction between fatigue and monotony or boredom in terms of overloading as opposed to underloading, but methods of separating the two in experimental studies are still not fully worked out and the interpretation of much previous work must be in some doubt. Thirdly, the main principles of how to prevent the adverse effects of monotony have been made fairly clear by the important researches done in the study of "vigilance". Fatigue effects still need considerable further investigation, but here are at least two theoretical "models", one postulating underactivity and one overactivity in the brain, that have enough support from other physiological and psychological studies and are sufficiently different from one another to provide a powerful stimulus to research. Lastly, much of the advance that has been made has resulted from attention to details of performance and of experimental conditions; the necessity of this as a means of working out the "mechanism" behind any observed effect is becoming increasingly clear.

- 1253 Wertheim, A. H. Oculomotor control and occipital alpha activity: A review and a hypothesis. Acta Psychologica, 1974, 38, 235-256.

Findings relating occipital alpha rhythm with the visual system appear to be difficult to interpret. This is due to the fact that the discrimination between oculomotor control monitored by visual input and monitored by other factors - a distinction which is independent of the presence or absence of visual stimulation - has been widely neglected. A review of the available evidence leads to the conclusion that the inflow of visual information itself has no relation with occipital alpha activity. Blocking occurs only when such information serves also as a monitoring principle in oculomotor position control. Some implications of this hypothesis especially in relation to the concept of alertness and arousal in tasks demanding a high level of visual attention, such as car driving, are discussed.

- 1254 Wever, R. Circadian rhythms of some psychological functions under different conditions. In A. J. Benson (Ed.), *Rest and activity cycles for the maintenance of efficiency of personnel concerned with military flight operations. AGARD Conference Proceedings*, No. 74, 1970. (Available from: National Aeronautics Space Administration, Langley Field, Virginia 23365; Attn: Report Distribution and Storage Unit)

Just as nearly all physiological functions, most measurable psychological functions show clear circadian rhythms. Their measurement requires, in contrast to that of physiological functions like rectal temperature, the wakefulness of the subjects. Therefore, measurements during night time can only be obtained, either when the subjects become awakened several times from sleep, or when they are continuously awake. In the first case, there are clear circadian rhythms, for instance in reaction time, with high performance during day time and low performance during night time. In the second case, the circadian amplitude of several functions decreases, coming from an approximation of the night values to the day values. This means: performance during night time is higher when subjects are continuously awake than when they are awakened from sleep at the same time, and this difference seems to be the greater the more performance depends on decisions. This may be of interest with regard to alert readiness.

Furthermore, it would be advantageous with regard to a continuous readiness if circadian rhythms of parts of a crew could be shifted, in order to have available at any time of the day a part of this crew at its maximum of efficiency. It has been proved, on the one hand, that, in strong isolation from the environment and under the influence of an artificial Zeitgeber being strong enough, human circadian rhythms can be shifted to any phase in relation to local time. But on the other hand, in shift workers which are under the influence of a reversed work-rest schedule, circadian rhythms remain unshifted; the reason is that they cannot avoid social contacts with unshifted people. Shifts against local time are only possible, (1) if personnel do not perceive the shift, (2) if personnel have no direct contacts with unshifted people, and (3) if the shifted Zeitgeber is strong enough. In order to have available two groups of a crew with circadian rhythms being reversed against each other, it is proposed to try to shift both groups for each 6 hours but into opposite directions, instead of shifting only one group for 12 hours.

- 1255 White, C. T. Eye movements, evoked responses and visual perception: Some speculations. *Acta Psychologica*, 1967, 27, 337-340.

In a number of studies dealing with the activity of the visual system it has been found that the duration of 250-300 msec appears to be critical in some manner. It is suggested that these findings (from studies dealing with fixation durations during visual search, evoked cortical potential patterns, and the temporal limitations in the visual perception of sequential events) may be related to certain aspects of the processing and assimilation of visual information.

- 1256 White, C. T., & Eason, R. G. Evoked cortical potentials in relation to certain aspects of visual perception. *Psychological Monographs*, 1966, 80, (24, Whole No. 632).

Evoked cortical responses were obtained in a number of studies dealing with various aspects of visual perception. On the basis of the variations noted in the complex response pattern under the different conditions it has been possible to identify certain components of that pattern as being related to specific aspects of the stimulus situation, such as intensity, color, and background level. In addition, the overall evoked response pattern appears to be directly related to phenomena encountered in the study of the perception of flickering stimuli.

- 1257 White, C. T., & Harter, M. R. Intermittency in reaction time and perception, and evoked response correlates of image quality. Acta Psychologica, 1969, 30, 368-377.

Three studies are reviewed which are of relevance to the Donders Centenary. The first deals with periodicities found in manual reaction-time distributions. The second with certain phenomena encountered in perception wherein sequential perceived events appear to be limited by central periodic processes. The third deals with an aspect of Donders' work not covered elsewhere in this symposium: his studies concerning the refractive errors of the eye.

- 1258 Wicke, J. L., Donchin, E., & Lindsay, D. B. Visual evoked potentials as a function of flash luminance and duration, Science, 1964, 146, 83-85.

Computer-averaged evoked potentials were recorded to visual stimuli of constant duration and varying luminance, as well as to flashes whose luminance and duration varied reciprocally. With constant duration, the latency, amplitude, and waveform of the evoked response varied as a function of luminance. The effects of decreasing the luminance on amplitude and waveform of the responses can be balanced by increasing the duration of the flash. This reciprocity between luminance and duration suggests a relationship between apparent brightness and evoked potentials.

- 1259 Wieringen, P. C. W. Van. Arousal en motivatie by vigilantietaken. [Arousal and motivation in vigilance.] Doctoral dissertation, University of Amsterdam, 1975.

It was concluded that the results were incompatible with the arousal theory, which would predict that the degree of vigilance decrement depended on the degree of arousal decrement. The only promising results indicated that sinus arrhythmia may be a useful correlate of vigilance performance, which is compatible with Kahneman's (1973) suggestion that, unlike the other peripheral physiological measures used in our study, sinus arrhythmia might reflect the "effort" Ss invest in their task. However, our experimental evidence on this point was rather weak and surely not conclusive.

The results with respect to the relation between "spontaneous" GSR activity during rest and detection performance were interpreted as being compatible with both Eysenck's (1963, 1967) prediction that introverts will be less prone to vigilance decrement than extraverts, and J. F. Mackworth's (1968, 1969, 1970) view that vigilance decrement is in part due to the habituation of the OR to task relevant stimuli.

- 1260 Wilkins, W. L. Some comments on the direction of the symposium. In W. Singleton, J. Fox & D. Whitfield (Eds.), Measurement of man at work. London: Taylor & Francis, 1971.

It is clear from our discussions that the exact place of the EEG, electromyography, sinus arrhythmia, evoked potentials, galvanic skin response, steroids, catecholamines, etc., is far from settled. Some of these physiological or psychophysiological measures have already an accepted place in ergonomics research and a few in ergonomics practice. Some have what appears to be a limited usefulness.

Now there are some jobs in the world of work so critical that psychophysiological monitoring of on-going performance is mandatory. At present, the astronauts are so monitored, I presume, when they are out in space. A few other jobs may deserve such intensive monitoring. Some tasks would profit from periodic or aperiodic sampling of physiological costs, to assure safety and health of workers or to assure vigilance in tasks where alertness is critical to performance. Most of the jobs in the world, however, do not merit such psychophysiological monitoring.

There can be little doubt of the usefulness of the physiological approaches to the study and design of man-machine systems. The physiological studies should, just as the observational studies, lead to clues for further study and hopefully to possible means of increasing human effectiveness together with human well-being.

Ergonomics constantly stresses the well-being of the worker, but it cannot relax in its emphasis. The intellectual climate in the universities the last few years has been such that students have begun to feel that the world of work is hostile and unfeeling and unrelated to human concerns. Misperception and misunderstanding of the real thrust of ergonomics is quite possible in a university climate of opinion which is so near to being anti-intellectual. Constant emphasis on health and on well-being as well as on efficiency, on productivity, and on performance is well advised.

1261 Wilkinson, R. T. Effects of sleep-deprivation on performance and muscle tension. In G. E. W. Wolstenholme & M. O'Connor (Eds.), The nature of sleep. Boston: Little, Brown, 1960.

Summarizing the results of this experiment, we can say that the effects of sleep-deprivation may be evident either in lowered performance or higher muscle tension during the work, and that an assessment of work-to-rest tension ratio may indicate which alternative will predominate in any individual. Two further suggestions of a tentative nature must await further research. The first is that the heightened tension with loss of sleep reflects a higher level of effort or motivation and possibly a greater cost to the organism of maintained performance after sleep-deprivation. The second is on a different level of explanation; it is that efficiency, in the mechanical sense of an input-output ratio, may be reduced by loss of sleep if we can consider performance as a measure of output (with respect to the task concerned) and muscle tension and the related measures of activation as an index of input.

In conclusion it should be stressed that this experiment is a preliminary study on a modest scale. It would be a mistake to generalize too freely from these results to other situations involving different tasks, different degrees of sleep-deprivation and even different measures of activation. In particular two limitations must be stressed: only one measure of activation was used, muscle tension, and only one muscular site was recorded from. For many subjects this combination may not have been the most sensitive index of activation. That it nevertheless provided a meaningful index in most of the subjects tested is suggested by the significant correlations with performance decrement which have emerged. In short the results seem to justify the modest means used in suggesting a clear relation in the present context between muscle tension, performance and the amount of sleep taken.

- 1282 Wilkinson, R. T. Muscle tension during mental work under sleep deprivation. Journal of Experimental Psychology, 1962, 64, 565-571.

Twelve Ss performed a 20-min test of addition, once after normal sleep and once under 32-56 hr sleep deprivation. Records of muscle tension (EMG) were taken from the inactive arm. The Ss who maintained performance best under the stress showed the greatest rise in EMG over normal levels. Knowledge of results disturbed this relationship. An independent measure of EMG taken under normal conditions predicted those Ss whose performance was impaired. Sleep deprivation may cause inefficiency even in Ss who maintain performance if their raised EMG reflects greater effort or energy expenditure; this may be the cost of maintaining normal levels of arousal and performance in face of the depressing influence of sleep deprivation per se.

- 1283 Wilkinson, R. T. Evoked response and reaction time. Acta Psychologica, 1967, 27, 235-245.

It is now possible, by the use of computer averaging techniques, to record clear evoked responses to sensory stimuli from the human scalp. This paper reviews some recent experiments which have sought to correlate the patterns of such responses with reaction time to the stimuli concerned. The conclusion is that the amplitude of certain components of the evoked response does indeed correlate with reaction time and that this correlation is probably due to the influence of attentional factors upon the behavioural and physiological measures concerned.

- 1284 Wilkinson, R. T. Relationship between CNV, its resolution and the evoked response. In W. C. McCallum and J. R. Knott (Eds.), The responsive brain. Proceedings of the Third International Congress on Event-Related Slow Potentials of the Brain. Bristol, England, 1973. Bristol: John Wright, 1976.

In this paper the author attempts to summarize and integrate the conclusions of three recent papers by himself and his colleagues on the relationship between, on the one hand, the CNV and its resolution and, on the other, the N1-P2 wave and what has been called the P3 or P300 wave of the evoked response.

The first conclusion is that any CNV which is present at stimulus onset will be returned to baseline as a function of the relevance of that stimulus to the organism. Thus CNV resolution may be expected to vary from a maximum, when prior instructions or training establish the propensity for a highly motivated operant response to a particular stimulus at S2 of the CNV paradigm, to no CNV resolution at all, when the stimulus by habituation and instructions is of minimal importance to the organism and requires no operant response.

Another factor which must clearly influence the size of the CNV resolution is the amplitude of CNV at stimulus onset. With no CNV there can be no return.

The second conclusion pertains to the relationship of CNV resolution to N1-P2 and possibly P3 waves of the evoked response. Since CNV resolution may continue from 100 msec, or earlier, to 600 msec post-stimulus, its presence in the post-stimulus trace may coincide with that of N1-P2 of the evoked response and also possibly P3 (or P300). When this happens the peak-to-peak amplitude of N1-P2 will appear artefactually large, and so will the amplitude of P3 (or P300). Thus any tendency for these two components to reflect the degree to which a stimulus is relevant to the organism, as defined above, may be due wholly or in part to summation with a CNV resolution which is itself varying with (a) stimulus relevance and (b) prior CNV amplitude.

- 1206 Wilkinson, R. T. The relationship between CNV, its resolution and the evoked response. In J. E. Desmedt (Ed.), Cerebral evoked potentials in man. In press.

In discussing the variation of event-related potentials in the EEG as a function of the relevance to the organism of the events concerned, this chapter advances the following two propositions:

Proposition I: The degree to which any CNV is returned to baseline as a result of a stimulus (CNV resolution) will vary with the relevance of that stimulus to the organism.

Proposition II: The CNV resolution usually takes the form of a relatively slow positive-going process, the latency of which is such that it may summate with discrete and relatively transient waves in the EEG which are due more directly to the stimulus itself. When this happens, effects of selective attention may be attributed to these discrete EPs which are in fact due to changes in the CNV resolution.

- 1208 Wilkinson, R. T., & Ashby, S. M. Selective attention, contingent negative variation and the evoked potential. Biological Psychology, 1974, 1, 167-179.

Contingent negative variation (CNV), N1-P2 amplitude of the evoked potential (EP), and positivity at 300, 400 and 500 msec latency (P300, P400 and P500) were measured in relation to task relevant (R) or irrelevant (I) tones presented alternately or unpredictably at 1 sec intervals. High concordance of P300, 400, and 500 indicated a slow, relatively unpeaked wave thought to be the CNV resolution. Both N1-P2 and P300 appeared small only when stimuli were both irrelevant and predictably so. With predictable presentation correlations were observed between CNV, N1-P2 and P300 in terms of both absolute level and, particularly, relevant/irrelevant difference. Holding CNV constant statistically, and to a lesser extent P300, reduced those correlations. It is suggested that CNV resolution in the post-stimulus trace reflects selective attention paid to the stimulus, and may be responsible, through summation, for claims that N1-P2, and sometimes P300, does so.

- 1207 Wilkinson, R. T., El-Beheri, S., & Gieseking, C. C. Performance and arousal as a function of incentive, information load, and task novelty. Psychophysiology, 1972, 9, 589-599.

Pulse and respiration rate, pulse volume, skin conductance level, and muscle tension were recorded from 12 Ss while they carried out a 40-min test of choice serial reaction in which incentive level, task difficulty (number of choices), and task novelty (or practice) were varied. 1) Little unanimity was observed among the physiological measures in responding to these task variables. Incentive was reflected in pulse rate, respiration rate, and skin conductance level; task difficulty in pulse volume; and novelty in respiration rate and muscle tension. 2) Only when the effects of information load and practice could be held constant was there any sign of an inverted-U relationship between performance and physiological level. 3) Although both choice and incentive had significant effects on performance, the two did not interact.

- 1268 Wilkinson, R. T., Fox, R. H., Goldsmith, R., Hampton, I. F. G., & Lewis, H. E. Psychological and physiological responses to raised body temperature. Journal of Applied Physiology, 1964, 19, 287-291.

The performance of 12 male volunteers in an adding test and in a test requiring prolonged vigilance was measured at normal body temperature and while temperature was maintained at 37.3, 37.9, and 38.5C. Each subject was measured at each level of body temperature on four occasions. Both the extent and the direction of the effect on performance varied with 1) the task being carried out, and 2) the degree of temperature elevation. Compared with performance at normal temperatures, the ability to add was impaired and vigilance was improved at 38.5 C. At 37.3C, on the other hand, smaller changes reflected in general an improvement in adding and an impairment of vigilance. As a result of the repeated sessions of controlled hyperthermia, the subjects became heat acclimatized but there was no corresponding improvement in performance at raised body temperature, indicating the absence of short-term adaptation of the central nervous system functions tested to repeated elevations of body temperature.

- 1269 Wilkinson, R. T., & Haines, E. Evoked response correlates of expectancy during vigilance. Acta Psychologica, 1970, 33, 402-413.

Pairs of clicks (ISI about 2 sec) occurred at quasi-random intervals for 22 min. The first click (S_1) served as a warning for the examination of the second (S_2), the occasional attenuation of which had to be reported. There were two levels of signal frequency, 10.9 and 87.2/hr. The amplitude of the contingent negative variation (CNV) in the EEG appearing between S_1 and S_2 was measured and also that of the evoked response (P_2-N_1) to the individual clicks. CNV was greater in the high signal frequency than in the low. In the high signal frequency a decline from first to second half of the test occurred in signals detected, speed of response, CNV, and evoked response to S_2 . Reasonably high positive correlations occurred between all pairs of these measures, but only one survived partial correlation holding time constant, namely that of CNV with signals detected. The CNV appears to reflect what is sometimes termed expectancy in vigilance, and also the level of detection performance independently of time. Its further links with conditioning may qualify it for consideration as a physiological adjunct of Holland's (1958) observing response.

- 1270 Wilkinson, R. T., & Lee, M. V. Auditory evoked potentials and selective attention. Electroencephalography and Clinical Neurophysiology, 1972, 33, 411-418.

Twelve subjects listened to a mixture of three short tones (135, 270 and 2268 c/sec) coming at random intervals ranging from 300 to 1760 msec and presented in series of short runs (average 25 tones per run). In each run one tone was designated relevant and the other two irrelevant. Subjects had to count the relevant tones, reporting the total at the end of each run. The EEG following each tone was averaged and showed the following characteristics for relevant as compared with irrelevant tones: (1) a greater amplitude of the conventional peak-to-peak measure, N1-P2; (2) a large, slow positive wave extending usually from latency 150 to about 640 msec; (3) a sharp positive wave, clear only in some of the records, at latency 300 msec. Selective attention performance was related to relevant/irrelevant differences in the positivity at 300 msec but not to N1-P2. It is suggested that the "late positive wave" is a return of pre-stimulus contingent negative variation (CNV) to baseline and that this, occurring selectively following relevant stimuli, constitutes the EEG sign of selective attention paid to the stimulus. Apparent changes in N1-P2 with selective attention may be due to its summation with the positive-going CNV return, N1-P2 itself remaining invariable.

- 1271 Wilkinson, R. T., & Morlock, H. C. Auditory evoked response and reaction time. Electroencephalography and Clinical Neurophysiology, 1967, 23, 50-56.

Ten human subjects listened to auditory "clicks" coming in runs of 50, the inter-click intervals varying randomly between 1 and 3 sec. In some runs the subjects ignored the clicks, in others they responded to each click as quickly as possible by pressing a key. Incentive was varied in the responding runs by payment at a flat rate or based on performance. For each run records were taken (1) of the auditory evoked response (AER) at the vertex to the clicks; (2) of the average reaction time in each responding run. Three identical test sessions were held on separate days.

Results were as follows: (1) Responding to, as opposed to ignoring, the clicks affected the various components of the AER in different ways: the 1st positive and 1st negative components (at latencies of about 50 and 90 msec respectively after the click) increased in amplitude, the 2nd positive component (about 160 msec) changed little, and the 2nd negative component (about 260 msec) was reduced. (2) In general, adding incentive reproduced these changes to a smaller scale. (3) Responding produced a large amplitude late wave in the AER, a possible "motor potential" of latency 350-450 msec, which was also increased by added incentive. (4) There was no correlation between reaction time and either the amplitude or the latency of AER components. (5) Great intra-subject consistency in AER patterns from one day to another contrasted with wide inter-subject variability.

- 1272 Wilkinson, R. T., Morlock, H. C., & Williams, H. L. Evoked cortical response during vigilance. Psychonomic Science, 1966, 4, 221-222.

In a conventional vigilance situation a relationship has been found between the averaged evoked cortical response to the vigilance stimuli and the Ss' ability to detect occasional, slight changes in these stimuli. The pattern of change in the evoked response that accompanied failures of detection suggested lowered arousal rather than distracted attention as the cause.

- 1273 Wilkinson, R. T., & Spence, M. T. Determinants of the post-stimulus resolution of contingent negative variation (CNV). Electroencephalography and Clinical Neurophysiology, 1973, 35, 503-509.

Subjects were six women. They heard a warning click (W) followed by one of two tones (S1), followed again by one of two clicks (S2). In half the trials they made a choice key pressing response (R) to the tone; in half no response (NR) was required. Within these trials they made a further choice response to the click (S2) if the tone at S1 was high tone (continued expectancy, CE) but not if S1 was a low tone (non-continued expectancy, NCE). The CNV present at S1 was resolved towards the baseline whether or not an overt response had to be made to S1 and whether or not the information in S1 counselled continued expectancy. With CE this CNV resolution was arrested when a further CNV developed in preparation for S2. This created a sharp divergence of the CE trace from the NCE trace, the latter continuing its positive - going resolution. The latency at this point of CE/NCE divergence correlated positively with motor reaction time to S1 and was delayed when a motor response was required to S1.

Conclusions: (1) The cause of return of CNV to baseline is neither the overt response nor the final decision concerning the nature of the stimulus, but probably the first coarse identification of the stimulus as one of a relevant class of stimuli. (2) The point of CE/NCE divergence may mark the completion of a second stage of finer analysis and may be an EEG index of final decision latency. (3) Inter-individual variance in reaction time is confined mainly to transactions before this point in processing. (4) The need to make an overt response may absorb processing capacity and therefore delay decision time.

- 1274 Williams, H. L., Granda, A. M., Jones, R. C., Lubin, A., & Armington, J. C. EEG frequency and finger pulse volume as predictors of reaction time during sleep loss. Electroencephalography and Clinical Neurophysiology, 1962, 14, 64-70.

The validity of EEG frequency and finger pulse volume for predicting reaction time increased as sleep loss increased. In general, the EEG showed the highest correlation with reaction time, especially in the 1 sec interval just before and just after the signal. As sleep loss increased, the "lead time" for the EEG increased so that by 50 h of sleep loss, valid predictions of reaction time could be made at least 2-3 sec before the signal. Five out of seven subjects showed a bimodal EEG frequency distribution during sleep loss. For these five subjects, perceptual-motor lapses occurred during periods in which the EEG frequency was in the theta rhythm (4-7 c/sec) range. For two of the subjects whose modal EEG frequency slowed somewhat, but did not have a secondary mode at 4-7 c/sec, neither the EEG nor finger pulse volume could be used to predict reaction time.

Finger vasodilation was significantly related to long reaction times during sleep loss, but its contribution to the prediction of reaction time was small.

- 1275 Williams, H. L., Kearney, O. F., & Lubin, A. Signal uncertainty and sleep loss. Journal of Experimental Psychology, 1965, 69, 401-407.

During a 3-5 day base-line period, 2 days of sleep loss, and 3 days of recovery, 52 Ss performed 3 visual vigilance tasks, of 10 min each ranging in signal uncertainty from complete redundancy to .84 bit per second. The major effect of uncertainty was to cause errors of omission which increased with sleep loss. The interaction between signal uncertainty and sleep loss was significant. Task duration (of 10 min) caused no impairment during the base-line and recovery phases, but during sleep loss, errors of omission rose sharply on the last 3 min of each task. There was no significant interaction between signal uncertainty and task duration. Decrement was considerably greater for Ss working alone than for Ss working in a group. Oral temperature had no consistent relation to errors of omission or to sleep loss.

- 1276 Williams, H. L., Lubin, A., & Goodnow, J. J. Impaired performance with acute sleep loss. Psychological Monographs: General and Applied, 1959, 73, (14, Whole No. 484).

With 49 Ss, deprived of sleep for 72-98 hr, performance deteriorated on a variety of tasks, an unusual result in studies of sleep loss. Deficit took the form of lapses (brief periods of no response accompanied by extreme drowsiness and a decline in EEG alpha amplitude). Four features of lapses were noted. (a) They occur in other conditions such as fatigue and hypoxia and appear to characterize impairment in general. (b) They increase in both frequency and duration as sleep loss progresses. (c) They are strongly affected by stimulus monotony. (d) Their specific effect on performance varies with the properties of the task. In S-paced tasks, for example, speed is the critical measure; in E-paced tasks, errors are critical. To identify the sensitive aspect of performance becomes the crucial problem.

- 1277 Williams, H. L., Morlock, H. C., Jr., Morlock, J. V., & Lubin, A. Auditory evoked responses and the EEG stages of sleep. Annals of New York Academy of Sciences, 1964, 112, 172-181.

As a subject moves from alert waking through drowsiness into light and then deeper stages of sleep, the wave form of the evoked response changes in a complex way. The earliest components (Allison's one to three) disappear from both anterior and posterior leads. In central and anterior locations the fourth component (peaking at 70 to 80 msec) increases in amplitude and duration. The fifth phase, which corresponds in latency to the K-complex, decreases in size, and may disappear altogether in the delta stages of sleep.

The average amplitude of the evoked response during stage 1_{rem} is lower than for the other stages of sleep, or for ordinary waking. A pilot study comparing two conditions of waking (reading a book, and counting clicks) revealed a response during reading which was somewhat similar to the typical response seen in stage 1_{rem}. Possibly, for the "dreaming" subject, the organization of the central nervous system is similar in certain respects to that for the engrossed reader. In both conditions the subject may tend to occlude irrelevant stimuli.

- 1278 Williams, H. L., Tepas, D. I., & Morlock, H. C., Jr. Evoked responses to clicks and electroencephalographic stages of sleep in man. Science, 1962, 138, 685-686.

The form of the average evoked response to clicks is highly correlated with the background electroencephalogram. However, the response during the emergent low-voltage "dreaming" stage is different from that seen during the low-voltage phase at the beginning of sleep. The results provide additional evidence that the emergent low-voltage stage is a neurophysiologically unique phase.

- 1279 Williams, L. G. The effects of target specification on objects fixated during visual search. Acta Psychologica, 1967, 27, 355-360.

When a person searches for a target in a cluttered visual field his fixations typically fall on objects. Specifying the target characteristics will affect the probabilities of fixating different classes of objects. It was found that for fields containing objects differing widely in size, color, and shape, a high proportion of fixations were on objects of specified color, but only a moderate proportion were on objects of specified size or shape. When two or more target characteristics were specified, fixations were generally based on a single characteristic.

It is suggested that the specification of the target creates a perceptual structure which S explores. The study of visual fixations, in effect, is the study of that structure.

- 1200 Williams, R., Bauknight, T., Cleveland, W., & Jackson, M. Phasic forearm blood flow (FBF) responses during the preparatory interval (PI) of a reaction time (RT) task. Psychophysiology, 1977, 14, 81. (Abstract)

A widely reported heart rate (HR) deceleration during the preparatory interval (PI) of the reaction time (RT) task has been interpreted by the Lacey's as reflective of a sensory intake set. A tonic skeletal muscle vasoconstriction has also been reported in association with sensory intake behavior. To determine the presence of phasic muscle vasomotor responses during a PI, 30 young adults were tested under the RT paradigm, under a HARD (30 msec S1 and S2 presentation, 15 trials) and an EASY (500 msec) condition. PI was 6 sec. All subjects were first required to count quietly while 15 6-sec HR and finger blood flow (FBF) "trials" were obtained (CONTROL). Beat-by-beat HR and FBF (venous occlusion plethysmography) levels during the PI were determined using a PDP-12 computer. Average sec-by-sec HR and FBF responses during the CONTROL condition were determined for each subject and submitted to polynomial regression analysis to test for linear and quadratic trends. Presentation of HARD and EASY tasks was counterbalanced. Tonic levels of both HR and FBF were significantly lower during the two tasks than during the CONTROL condition. HR and FBF did not differ between tasks, though performance measures confirmed the higher difficulty level for the HARD task. While the phasic HR response was nearly flat during the CONTROL condition, a greater quadratic component for both HARD, $F(1/981)=48.34$, and EASY, $F(1/981)=31.84$, tasks confirmed the presence of a biphasic acceleratory-deceleratory response with addition of PI. A significantly greater linear component during both HARD and EASY tasks showed that the overall rate of fall in FBF was accentuated by addition of a PI. A greater quadratic component for both HARD, $F(1/981)=7.20$, and EASY, $F(1/981)=8.21$, tasks in comparison to the CONTROL condition indicates that the addition of a PI resulted in a greater rate of fall in FBF during the first 3 sec of the PI. The order of task presentation had significant effects upon FBF response. Whichever task came last showed a greater rate of FBF fall during the last half of the PI; this order effect was more pronounced when the HARD task was last, suggesting a task difficulty effect.

These findings show that the phasic peripheral cardiovascular responses during a PI are not limited to HR, but may be extended to include a more pronounced concurrent phasic vasoconstriction in the forearm. The early FBF fall may represent the mechanism for a diastolic BP increase reported by Obrist et al. (1974) to occur early in the PI.

- 1201 Williams, R. B., Jr., Bittker, T. E., Buschsbaum, M. S., & Wynne, L. C. Cardiovascular and neurophysiologic correlates of sensory intake and rejection: I. Effect of cognitive tasks. Psychophysiology, 1975, 12, 427-433.

In this study of the relationship between sensory processing and cardiovascular function, five cardiovascular parameters were monitored during baseline periods and during tasks requiring either sensory intake or sensory rejection behavior on the part of 19 subjects. Sensory intake behavior was associated with a pattern of response similar to that seen with activation of peripheral sympathetic nerves - vasoconstriction in both the digit (skin) and forearm (skeletal muscle). In contrast, sensory rejection behavior was associated with vasodilation in the forearm and vasoconstriction in the digit. Individual differences in an EEG measure of characteristic ways of processing sensory information were predictably associated with differences in resting cardiovascular function. The association of sensory intake with a skeletal muscle vasoconstriction may help to extend our understanding of the physiology of sensory processing, since heretofore only heart rate and somatic motor activity have reliably differentiated sensory intake from sensory rejection behavior.

- 1202 Wilson, R. S., & Duerfeldt, P. H. Cardiac responsiveness and differential conditioning. Journal of Comparative and Physiological Psychology, 1967, 63, 87-94.

Discrimination difficulty was systematically varied in 2 experiments involving a visual discrimination problem. During 60 trials of differential conditioning with a shock US, beat-to-beat pulse-rate changes, measured for selected trials, showed a characteristic biphasic pattern on nonshock trials—initial deceleration followed by acceleration. Shock-produced changes were similar although acceleration was more prominent. Magnitude of change was related to discrimination difficulty and did not depend on training procedure (converging discriminable stimuli vs. maintaining fixed level of difficulty throughout). Results replicate a previous study and generally conform to Liddell's analysis of differential conditioning. Vigilance is proposed as the intermediary process linking discrimination difficulty to magnitude of pulse-rate change.

- 1203 Wilson, S., Orne, M., & Paskewitz, D. Individual differences in the interaction between alpha density and arousal. Psychophysiology, 1977, 14, 103-104. (Abstract)

The widely accepted inverted U hypothesis relating alpha density and arousal is specifically challenged by Orne and Paskewitz's (1974) recent study. Further analysis of the interaction between alpha density and activation in this experiment demonstrates striking individual differences in alpha response to arousal beyond relaxed alertness. In response to threat of shock during alpha feedback several subjects demonstrated the expected reduced levels of alpha but several others showed an equally dramatic increase in alpha density in association with increased arousal. Further, these individual response patterns were quite consistent on a second day of shock threat during feedback, and what is more, the interaction between alpha density and heart rate changes could be predicted from the number of spontaneous skin conductance responses on an earlier day.

A reanalysis of Stennett's (1957) classic study, most commonly cited as evidence for the inverted U hypothesis, shows that identical individual differences are present and that the U-shaped function was the result of combining data from the two extreme types of responders. It was inferred, but not justified by data, that these two groups were at different levels of arousal.

These powerful individual differences have not been generally recognized because they are easily masked by overriding visuomotor effects if light is present or by novelty effects during a first session.

- 1204 Wisner, A. Electrophysiological measures for tasks of low energy expenditure. In W. Singleton, J. Fox & D. Whitfield (Eds.), Measurement of man at work. London: Taylor & Francis, 1971.

It is obviously naive to try to reduce the extraordinary complexity of relations between man and machine to a pure physiological phenomenology. All the psychological exploratory techniques available are also necessary. Nevertheless, working difficulties of man-machine systems are sometimes revealed earlier by an impairment of the operator than by a change in the behaviour of the system. Moreover, physiological measures encourage us to consider more particularly the overloading of the human operator and the effects on his health. Finally, if we are looking for the cause of trouble in the functioning of the system, we cannot neglect the information given by man's perceptual and motor links. The careful observation of an exploratory modality, or of execution difficulties might explain and solve previously intractable problems.

All of these considerations encourage close collaboration in the future between psychologists and neurophysiologists in the study of man-machine systems.

1200 Wood, C. C., Goff, W. R., & Day, R. S. Auditory evoked potentials during speech perception. Science, 1971, 173, 1248-1251.

Neural responses evoked by the same binaural speech signal were recorded from ten right-handed subjects during two auditory identification tasks. One task required analysis of acoustic parameters important for making a linguistic distinction, while the other task required analysis of an acoustic parameter which provides no linguistic information at the phoneme level. In the time interval between stimulus onset and the subjects' identification responses, evoked potentials from the two tasks were significantly different over the left hemisphere but identical over the right hemisphere. These results indicate that different neural events occur in the left hemisphere during analysis of linguistic versus nonlinguistic parameters of the same acoustic signal.

1200 Wood, C. G., Jr., & Hokanson, J. E. Effects of induced muscular tension on performance and the inverted U function. Journal of Personality and Social Psychology, 1965, 1, 506-510.

It was hypothesized that heart rate, as a function of increasing levels of induced muscular tension, would increase linearly throughout the range of tension, whereas, performance on a simple intellectual task, would progressively increase up to a moderate level of tension, beyond which it would progressively decline. A group of 100 undergraduate students enrolled in an introductory psychology course, equated for basal level heart rate, were divided into 5 groups. Each group was subjected to 1 of 5 levels of induced muscular tension. Heart rate and performance on the intellectual task were measured before and after the induced tension, and the computed differences recorded as the measure of change. These differences, analyzed by means of an analysis of variance, revealed significant differences for both heart rate and performance. In addition, trend tests were performed to see if these differences followed the predicted trends. It was found that heart rate displayed a significant linear trend across conditions, whereas performance scores manifested the predicted significant quadratic component.

1207 Woodruff, D. S. Relationships among EEG alpha frequency, reaction time, and age: A biofeedback study. Psychophysiology, 1975, 12, 673-681.

To examine the relationship between the frequency of the EEG alpha rhythm and reaction time, the biofeedback technique was used to manipulate brain wave frequency in 10 young and 10 old subjects. Subjects first learned to increase the percent time they spent in their modal brain wave frequency, and then they were trained to increase the percent time they spent in brain wave frequencies 2 Hz faster and 2 Hz slower than their modal frequency. Simple auditory reaction time (RT) was measured during biofeedback immediately after subjects reached a set criterion at each biofeedback task. To control for the effect of biofeedback training on RT, groups of 5 old and 5 young subjects heard a pre-recorded feedback signal which was not contingent upon their brain wave activity. Experimental subjects increased the abundance of alpha activity above baseline levels while control subjects did not. Results indicated that experimental alteration of brain wave frequency affected RT. When the subjects produced fast brain waves their RT was significantly faster than when they produced slow brain waves. Correlations between brain wave period and RT were small. Thus, the data did not provide unequivocal support for the notion that the alpha rhythm serves as a master timing mechanism for behavior, but the relationship between controlled EEG activity and RT was clearly demonstrated.

1988 Worden, F. G. Attention and auditory electrophysiology. In I. Stellar & J. M. Sprague (Eds.), Progress in physiological psychology (Vol. 1). New York: Academic Press, 1966.

A more general conclusion is that research of this kind has to treat both aspects (behavioral and neurophysiological) as unknowns because of critically significant disparities in data and concepts between psychological and neurological disciplines, and because of the lack of information in both. For example, it is a curious strategy to study evoked-potential changes of unknown neural significance in an attempt to clarify neural mechanisms in such a complex and obscure behavioral process as attention. An analysis of this problem was presented and certain concepts were proposed concerning perception and attention in relation to neural activities. This analysis indicates that the urgent need is for better questions, rather than for more answers to poor questions. The question of neural mechanisms in attention cannot even be stated clearly, let alone answered, without knowing more about how neural activities process information to yield the kind of information necessary for adaptive behavior. A great many simple questions, derived from adequately complex conceptualizations, are going to have to be answered before it becomes possible to imagine how perceptions might arise from brain activities.

1989 Wright, J. M. von, Anderson, K., & Stenman, U. Generalization of conditioned GSRs in dichotic listening. In P. M. A. Rabbitt & S. Dornic (Eds.), Attention and performance V. New York: Academic Press, 1975.

In a dichotic listening task GSR was conditioned to a specific word (CS) in the attended message by pairing CS with shock. In a subsequent test task GSRs were obtained to the occurrence of CS in the unattended message. Weaker but statistically significant GSRs were obtained to a synonym of CS and to a word acoustically similar to CS when they were presented either in the attended or in the unattended message, the size of the effect being similar in these four cases. The results suggest that the unattended message in dichotic listening tends to be processed at a semantic level even when its content cannot be reported by S. The Ss' shadowing performance tended to deteriorate following repeated presentations of critical words in the unattended message, suggesting an increase in the sampling of that message.

Y

- 1200 Yaremko, R. M. The effects of direction and amount of change in stimulus intensity on magnitude of the orienting reflex and frequency of signal detection (Doctoral dissertation, Ohio University, 1969). Dissertation Abstracts International, 1959, 30, 1936B. (University Microfilms No. 69-17, 054)

The purpose of this experiment was to obtain information on the magnitude of the orienting reflex (OR), as measured by the galvanic skin response, as a function of direction and amount of change of the orienting stimulus (OS), and to evaluate the effects of evocation of the OR on detection of a subsequent signal in a vigilance task.

Forty Ss were given sequences of trials in which OSs and detection stimuli (DSs) were paired and presented alone. Ten additional Ss were given only DSs. The OS was defined by a change in room illumination, and the DS by a brief threshold tone, the intensity of which was determined empirically for each S.

It was found that ORs to the large change stimuli were significantly greater than ORs to the small change stimuli, but that no differences occurred between upward and downward changes in either the large or small change conditions. Greater habituation of the OR occurred to the small change stimuli. More signals were detected on trials in which an OS preceded the tone, and detection performance declined over trials in both the OS-DS and DS-only conditions. The experimental Ss did not differ from the controls in basal skin resistance or number of signals detected on DS-only trials. Negative correlations were obtained between (1) basal skin resistance and total detections, (2) habituation of the OR and decrements in detection performance, and (3) habituation of the OR and differences in detections in the OS-DS and DS-only conditions.

It was concluded that OR magnitude was a function of amount rather than direction of change in stimulus intensity, and that occurrence of an OS just prior to delivery of the DS aided in detection of that stimulus. Although a conditioning interpretation of this finding was ruled out, the relationships obtained between electrodermal activity and vigilance performance did not lend exclusive support to any one theoretical account of attention facilitation.

- 1201 Yingling, C. D. Evoked potentials to combined auditory and visual stimuli in three dimensional space. Psychophysiology, 1977, 14, 94. (Abstract)

Most evoked potential research utilizes stimuli in a single sensory modality. However, in the real world outside the laboratory, events often are seen as well as heard simultaneously. Thus, the interaction between the neural events in at least two sensory systems characterizes the way our brains normally process information from the environment.

To examine this interaction, a stimulus field was created in which visual (flash) or auditory (click) stimuli could be presented from either the left, center, or right side of the subject's egocentric field. Flashes and clicks were always presented together, but on separate quasi-random schedules so that light and sound sometimes coincided in space and sometimes did not. A total of nine combinations was thus created; evoked potentials were recorded from homologous frontal, central, parietal, and occipital locations over each hemisphere.

By changing the instructions to the subject, a number of current hypotheses concerning the effect of attention on evoked potentials could be tested. For example, directing attention to the flashes caused a relative enhancement of the posterior components of the complex response whereas attending to clicks shifted the pattern of maximal response more centrally. More interesting were the effects of detecting a specific combination of click and flash on the late positive (P300) components of the responses. When the click and flash came from the same location in space, a subjectively unambiguous event, a clear P300 was seen only in the evoked response to the detected combination and not in the other eight. However, when the click and flash did not coincide, the correct detection was much more difficult, and P300 components appeared in not only the target combination, but also in others which were similar to the target in the spatial location of one or the other component. Thus, P300s accompanied the identification and rejection of certain non-target stimuli as well as the classical condition of detection of a rare target.

Z

- 1292** Zingerman, A. M. Characteristics of cardiac activity in a man-operator in a control process. Fiziologicheskii Zhurnal SSSR, 1972, 10, 1527-1534. (NTIS No. JPRS 58092)

Analysis of ECC dynamics in a man-operator during sensomotor tracking of an object disclosed two types of cardiac reactions -- intensive sympathetic type reactions and weak parasympathetic type reactions. These two categories of reactions turned out to be stable characteristics of the examined individuals and were well correlated with the tracking quality indices. Dispersion and factorial data analysis confirmed the observed differences. The article attempts an interpretation of the obtained data from the viewpoint of automatic control theory.

- 1293** Zwaga, H. J. G. Psychophysiological reactions to mental tasks: Effort or stress? Ergonomics, 1973, 16, 61-67.

Discusses the implication of the mental load model, used implicitly or explicitly by many investigators, in studies of psychophysiology. It is suggested that the model's implications are inconsistent with many experimental results. An experiment with 16 Ss is described which demonstrates that a clearer picture emerges if the concept of arousal is taken into consideration.